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THE MEDICOLEGAL NECROPSY

A Symposium Held at the Milwaukee Meeting of the American Society of Clinical Pathologists, June, 1933

INTRODUCTION

FREDERIC E. SONDERN

Chairman, Committee on Necropsies, American Society of Clinical Pathologists

This symposium embraces a series of articles of a definitely specialized character dealing with the determination of the cause of death in supposedly criminal cases as well as in some others which are also subject to review in courts of law. The result of such work often has a direct bearing on the conviction or acquittal of those accused of crime, and its methodical accuracy by specially qualified men with unusual experience has become a material aid in jurisprudence.

The "Coroners System" so universal in our country, means briefly an officer elected by his political party who appoints a local physician deputy to perform his medicolegal necropsies. His tenure of service is possibly but one term when he may be followed by a similar officer and deputy physician of other political affiliation. It stands to reason that no definitely expert service by specially qualified men with long experience can be developed in this way. With a full realization of the shortcomings of that system, the medical profession for years advocated its replacement by a Medical Examiner whose qualifications and service should be modelled on European usage.

The Medical Examiner is a civil service non-political appointment for life or at least a long period of years, the selection being made from a list of fundamentally qualified medical men. He organizes an office with such assistants as he may need and a laboratory with specialists in toxicology, histological pathology

and what not according to the extent of the service. A number of the large cities of the nation have now replaced the Coroner in this way with the result of a far more effective system as can easily be evaluated from the articles published herewith. Every city of sufficient size will do well to make the same change and if the size of the town does not justify these modern facilities for expert work such service can embrace a county, several counties or even a state.

Evolution in the service of the various Medical Examiners has demonstrated the fact that it is even difficult to secure properly qualified assistants for these services to say nothing of proper candidates for the positions of Medical Examiner. The various medical schools were appealed to for the establishment of post-graduate courses of special instruction for the purpose of better qualifying such candidates. The fall of 1933 saw the opening of the first unit of this kind, by the University and Bellevue Medical College of New York University. These courses in forensic medicine will include a series of lectures to undergraduates during the second semester of the fourth year and additional elective courses for them in the various branches of this specialty. Post-graduate courses will also be arranged to include comprehensive work for the qualification of Medical Examiners. These courses are now being established largely by the authors of the articles published herewith, all men in active service with a constant large amount of demonstrable material. Thus the undertaking will do much to advance forensic medicine and create needed specialists of this kind.

The careful post-mortem examination of the human body to learn the details of the causes of death in any case is without doubt one of the greatest factors in the progress of the accurate diagnosis of disease. This is so well evaluated by the pathologist Horst Oertel in a publication twenty years ago on the history of the autopsy in the development of scientific medicine, that a condensed review of his outline seems justified. It appears that Italy deserves the credit for the first step. While preceded by earlier workers of note, Morgagni in 1767 was really the first to correlate the change found at autopsy with symptoms of disease.

His was a pathologic-anatomic explanation of symptomatology rather than a system of pathology. Bichat in France soon after (1771–1802) based his throey of the *development* of disease on extensive studies of general anatomy in distinction to the establishment of the *seat* of disease by Morgagni. The Frenchmen Corvisart and Laennec, largely on the basis of Bichat's work saw in it the fundamentals of physical diagnosis. Subsequently these two men, though not actually the originators, perfected percussion and auscultation, Corvisart in 1808 and Laennec in 1815–1819. Austria became prominent soon after by the work of Rokitansky (1804–1878) in Vienna. He traced the character and relationship of processes of disease by modern general pathology and particularly histologic pathology.

It is evident throughout in following the progress of medicine, that it went hand in hand with and was largely based on work on the cadaver, and nowhere is this more apparent than in the study of medical progress in Germany. During the first half of the nineteenth century under the speculative natural philosophy of Schelling, Germany remained far behind France, England, and Austria where serious efforts to overcome such purely speculative ideas and systems was making rapid headway. While Rokitansky in Austria and Corvisart and Laennec in France were establishing pathology as the foundation for diagnosis, Germany was still in the grasp of battling schools and systems such as homeopathy of Hahnemann, polypragmasia, Rademacher's system, Priessnitz' system, Mesmerism, etc. An illustration of what was taught in pathology can be seen from a translation of few sentences from a syllabus entitled: The Natural Families of Diseases (Berlin 1851).

> Disease has, although it represents a process of death, an organic combination of several actions, which develop from the innermost part of one nucleus. This nucleus is its principle. Disease grows from this nucleus to a system of actions. In this system the nucleus represents the fundamental action, the stem of the disease, from which extend many branch actions as for instance constipation, colic, vomiting, fever, etc.

It becomes more ridiculous as it continues.

Virchow, that great father of pathologic anatomy in Germany

said at the beginning of his outstanding career in 1854, "German medicine on account of its views and dissenting schools has been the laughing stock of the world." Definite as was the lack of progress in medicine in Germany during the first half of the nineteenth century in which period pathology was completely neglected, just so pronounced was the advance to a position of greatness and leadership during the second half of that century in which period Virchow did more to establish pathologic anatomy as the foundation of clinical medicine than any other man before or since. He taught and demonstrated at the autopsy table with a system, perseverance and force never approached before, that every disease represented an antomically localized process and that therefore the goal of all pathologic conceptions must be objective knowledge of and location of the diseased processes—no speculative idea.

Upward of twenty years ago Richard Cabot of Boston rather startled the profession in his arguments favoring post-mortem examinations, with the publication of the percentages of correct clinical diagnosis of what appeared to be the most important lesion revealed by 3,000 autopsies. Only a few of the more evident diseases exceeded 75 percent in the hands of an experienced diagnostician, many important diseases falling below 50 percent in recognition and some even below 25 percent.

About the same time, namely twenty years ago, Corwin in a statistical study of the percentages of autopsies obtained on persons dying in hospitals in the United States compared with those in other countries, demonstrated the striking fact that the figures in our largest hospitals were much lower than those in similar institutions elsewhere. The average percentage of autopsies in the stated number of the largest hospitals in the various countries was as follows: United States, seventeen hospitals average 22 percent. Canada, three hospitals average 60 percent. England and Scotland, five hospitals average 76 percent. Germany and Austria, eight hospitals average 90 percent. Of course these figures have undergone much change in these last two decades and while there has been a very decided improvement in our own figures they are still not comparable with those of the other coun-

tries. The reasons for our difficulty in obtaining autopsies on persons dying in hospitals are, the claims of the anatomical departments of our medical schools for unclaimed cadavers, adverse public opinion to autopsies, the autopsy law, and the undertaker's objection to an autopsy.

The claims of the anatomical departments of the medical schools on unclaimed cadavers for purposes of dissection by students and others are regulated by law which only too frequently robs the clinical and pathological departments of the hospital of the benifits of post-mortem study in these cases. This problem has not been solved as yet and unfortunately the Continental system of clearing all anatomical material through the pathological department would be difficult if at all possible to introduce.

Adverse public opinion to autopsies has been considerably reduced in recent years by the increase in public health education by means of lectures, radio addresses, magazines and newspapers with the result that religious and other scruples are being overcome. The tact and sympathy of the hospital official whose task it is to obtain consent to an autopsy is most important and now generally realized.

The laws concerning necropsies vary in the different states of the Union and as a whole obstruct rather than facilitate securing post-mortem examinations. For example, the former law in New York was such that almost anyone could claim a body, and could prevent an autopsy by withholding consent. It was a common practice for undertakers to claim bodies, prevent an autopsy and then seek next of kin more diligently perhaps than the hospital did. Largely through the efforts of the New York Academy of Medicine the law was recently changed and now prevents this and other evils, but it is not yet a model law. The matter of framing a uniform model law and having it enacted by the various states in the interest of medical science is one which deserves serious attention on the part of medical educators and the profession generally.

The undertaker's objection was found to be perhaps the most important obstacle to an autopsy, at least in the City of New York, by his quiet firm advice against it to members of the family

arranging for the funeral. This attitude can easily be understood when realizing the relatively large number of post-mortem examinations formerly made by junior hospital physicians as well as the frequent disregard even by the experienced pathologist of the need of leaving intact structures required for proper and uncomplicated embalming. Realizing the importance of securing the good will of the undertakers to eliminate their objections, a joint committee was formed to represent the New York Academy of Medicine, the New York Pathological Society, and the Metropolitan Funeral Directors' Association. This Committee prepared a report the value of which is such that it has been included in the papers published in this monograph. It has also been printed in display form and is posted on the walls of every autopsy room in New York. A Subcommittee on Grievances was also created and is subject to call at any time to adjudicate complaints by a pathologist or a funeral director as the case may be. While such grievances were rather frequent at first there has not been a single one in the last six months. The benefits which have come to both the pathologists and the funeral directors are such that a similar arrangement in other large centres is urged.

THE MEDICOLEGAL SYSTEM OF THE UNITED STATES

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INTRODUCTION

It is perhaps fitting that a discussion of the medicolegal system of the United States should introduce a symposium on the medicolegal necropsy. Such a discussion will have to deal with the system that prevails throughout the greater part of the country. That system is the one with which most of you, as pathologists, come in contact. The prevailing system leaves much to be desired. What I shall discuss, therefore, forms a contrasting background for what is to follow by those who work under a better system that is in use in only a few localities.

I am not sure that any suggestions that I may make for improving the status of legal medicine in the Unites States will have the complete approval of you who, as pathologists and experts in laboratory medicine, may receive some financial gain from your participation in the workings of the existing system. I maintain the thesis that the important subdivision of legal medicine which has to do with "the application of expert medical knowledge to the needs of law and justice" (Oertel[2]) is just as much a function of government as is the administration of justice itself. A system that would make available to the administration of justice the best type of medical service would necessitate some form of fulltime or parttime service that would probably take away from some of you some of the odd jobs that you perform under the present system. But I am sure that you will be willing to subordinate such opportunities for minor personal financial gains to the greater good of society at large.

APPLICATION OF MEDICINE TO LAW

The application of medical knowledge to law occurs along several lines that have been left more or less distinct under the American system. First comes the investigation of those deaths into whose causation the element of criminality or accident may have entered. Of equal importance are questions involving the mental status or legal responsibility of one accused of crime. Fatal and nonfatal injuries to the person through accident or casualty present many perplexing problems that find their way into the civil courts. A final application of medicine to law is that which concerns the use of medical and other sciences in the detection of crime and in the apprehension and identification of suspects.

These various legal aspects of medicine often involve the manner of presentation of medical facts and opinions to the legal tribunal. This carries over into the field of expert medical testimony, an important subdivision of legal medicine that can receive no more than this brief mention here. Medicolegal psychiatry concerns the pathologist only in so far as neuropathologic or laboratory questions may be involved. The pathologist may occasionally be called upon in personal injury cases, and his aid is sometimes sought by the police, but the most important medicolegal activities of the pathologist come into play in connection with the first of the applications of medicine to law mentioned above, namely, the investigation of supposedly criminal or accidental deaths. It is this aspect of our medicolegal system that I propose to discuss more fully.

THE CORONER

Except in a very limited number of jurisdictions, the investigation of deaths that require the attention of an agency of government is made by the office of coroner. It is not necessary to trace the history of this ancient and honorable office, save to mention that it was transplanted from England to the original colonies. From them it was transferred to the states. In twenty-four of the states the office is unfortunately provided for

by the state constitution. I say unfortunately, because the mere mention in the constitution that there shall be such an office as that of coroner makes necessary a constitutional amendment if the office is to be replaced by the more efficient system under which others taking part in this symposium work.

The duties of coroners are prescribed by statute. In most states these laws were framed when a rural type of civilization prevailed and the population was widely scattered. The condensation of population into large industrial urban and suburban communities has brought about conditions that did not exist and that could not be foreseen when the original laws were drawn. The statutes relating to coroners have undergone no essential modifications that would better fit them to meet modern conditions.

No one will question the need of official inquiry into the cause and manner of certain kinds of deaths. Suspected homicide certainly belongs in this category. If death is presumably due to suicide, the coroner must act because death due to the unlawful act of another must be excluded. In most jurisdictions deaths due to accident or casualty must also be investigated by the coroner, because criminal or negligent actions of others may be involved. The coroner's investigation assumes great importance in suicidal and accidental deaths, not only because of their possible criminal or negligent content, but because important civil questions relative to workmen's compensation and accident and life insurance may be involved. A previous analysis[3, 4, 5] of the kinds of deaths requiring such official action as is here discussed revealed that in five populous jurisdictions homicidal deaths constituted only 1.6 to 6.5 per cent of the total, suicide only 5.4 to 9.5 per cent, and casualty from 30.3 to 40.7 per cent. In four of the jurisdictions, all forms of violent death constituted only 39.6 to 49.1 per cent of the total; in the fifth jurisdiction the figure was 56.7 per cent.

The physician will be quick to recognize still another group of cases in which some sort of official action is necessary. The layman and the lawyer give little thought to this group, although their importance is evident from the fact that they made up more

than half of the totals in the jurisdictions whose figures were analyzed. These are the deaths of persons who have not been attended by a physician and who are dead or dying when the physician arrives. The physician has no right to issue the death certificate in such a death, although he is frequently importuned to assume this responsibility and sometimes does assume it. The responsibility of issuing or authorizing a death certificate rests with an agency of government, which agency in most localities is the office of coroner.

THE CORONER'S NECROPSY

In no instance can the cause and manner of death be determined with the scientific accuracy that should be required by law without a necropsy. Many, and especially many physicians, seem to think that the coroner has unlimited authority in the matter of performing or authorizing a necropsy. It might be a good thing for the future of medicine and of humanity if coroners did have such broad authority, provided it were intelligently used. Vital statistics as they relate to causes of death and to the incidence of disease would certainly be more accurate than they are at present. But the coroner's office is not a diagnostic service, and in the determination of the cause of nonviolent deaths the activities of the office are restricted.

In the performance of necropsies the coroner is restricted to those instances in which death is presumably due to violence. He can presume that death is due to violence until proved to the contrary by necropsy. As a matter of fact, in many jurisdictions the coroner does necropsies in nonviolent deaths upon the basis of such an assumption. In most of the legal actions brought against coroners for the illegal performance of necropsies and in which the verdict has been against the coroner, the adverse judgement has been based upon the fact that he did not have sufficient reason to warrant him in assuming that death was due to violence. Apparently there must not be a merely negative presumption that death may have been due to violence until proved otherwise by necropsy, but there must be strongly positive presumption that death was due to violence before the necropsy is done.

The trend of legal opinion, in those instances in which higher courts have had to determine whether the coroner had overstepped his authority, seems to consider the coroner's necropsy a part of the inquest, and not something apart from the latter which might lead to an inquest. Such an interpretation of the statutes would result in extreme restriction of the authority of the coroner in some jurisdictions. I am referring now to the magisterial or quasi-judicial inquiry known as the inquest, as opposed to the mere preliminary investigation or view of the dead body. In only eight states and the District of Columbia are the statutes so worded as to authorize an inquest if the deceased was unattended by a physician and the cause of death is unknown. In four states deaths due to casualty or accident are subject to inquest, but deaths due to unknown causes are excluded. In the remaining states, excluding the New England states that use the medical examiner system, the holding of inquests is restricted to those deaths that are presumably due to "unlawful means" or to the "criminal or unlawful act of another." Perhaps in the small number of states of this group, whose statutes include the words "default or negligence of another," this phraseology might be construed to include deaths due to casualty.

THE CORONER'S INQUEST

The restrictions that hedge about the holding of inquests seriously limit the authority of the coroner. But even in those instances in which the statutes of every state authorize an inquest, namely deaths due to suspected murder or manslaughter, the inquest would appear to be a most futile and inutile procedure. It is futile because of the lack of training in law or criminology of the average coroner and because of the character of the average coroner's jury. It is useless because the kind of investigation that the coroner's inquest is belongs more properly in the hands of the prosecuting attorney, who is responsible for the conduct of the criminal legal procedure that may arise out of the investigation. Emphatic attention has been called to the useless, and often harmful, character of the coroner's inquest by Joseph Du Vivier,[1]

a former assistant district attorney for New York County, who said:

> The coroner does nothing that must not be done over again. No reliance can be placed on anything that he has done, nor can he be trusted to do anything right. Every case in which there may be criminal responsibility must be watched.

Many changes are necessary if the coroner's office is to become the efficient, modern medicolegal agency that it should be in our system of judicial administration. One of the most fundamental and important changes is the abolition of the coroner's inquest as a function of the coroner. By making the prosecuting or state's attorney responsible for the inquisition that the coroner now conducts, not only would duplication of work be avoided and better work be done in criminal cases, but the costs of jurors' and witness' fees entailed by the coroner's inquest would be eliminated.

CAUSES OF POOR FUNCTIONING OF THE CORONER'S OFFICE

What has been said is condemnatory of the office of coroner as an agency of government. Individual coroners differ in intelligence, in general ability, and in the efficiency with which they perform the duties of their office. But chief condemnation falls not upon the individual who may be coroner, but upon the office itself as a part of the governmental machinery. The faults of the office are largely those of the laws under which it works. The office is an elective one. It is an obscure political office that is usually passed out to some minor light in the partisan political organization. In some jurisdictions it does not have even this doubtful distinction and may be had for the asking by one who has not yet attracted political attention. The tenure of office is short. Although the office has duties of a highly technical or specialized medical and legan character, in most states no qualifications are required of aspirants for the office.

The authority of the coroner in the performance of his duties is, as has already been indicated, poorly defined. The laws relating to the office have been made antiquated by changed conditions. To quote Du Vivier again:

> A dispassionate study of the office leads one to the inevitable conclusion that it is an institution of government wholly unsuited to the needs of the day.

Perhaps the most fundamental problems connected with the functions of the coroner's office arise out of the fact that it is of variable importance in different states and in different units of the same state, a fact that the laws relating to the office fail to recognize. In 1932 there were only seven inquest cases in each of two Illinois counties. In 1930 there were 4,098 inquest cases in Cook County of the same state. It is obvious that the latter jurisdiction makes much heavier demands of its coroner's office than does either of the other two counties. However one or a few homicides in a rural community may be just as disturbing to the social structure and may demand just as careful work in a just administration of justice as a larger number of similar cases in a metropolitan area. Until this difference dependent upon population is recognized by society, the important medicolegal work of a congested urban jurisdiction will continue to be hampered by laws that function none too well even in a sparsely settled rural county. In the failure to recognize the relation of density of population to the work of the coroner the American governmental system reveals its failure to recognize an important feature of the English coroner system. The latter has long made a distinction between coroners of counties, coroners of boroughs, and coroners of the city of London.

IS THE CORONER'S OFFICE NECESSARY?

There would be little logic in criticizing the coroner's office as a medicolegal agency if nothing better could be or had been devised to take its place. We have lived so long with the office that some seem to think that life and government without the office are impossible. But a number of states get along as well, but not necessarily any better, without county coroners than do many states with coroners. In seven states the office of coroner does not exist, justices of the peace performing the duties usually assigned to coroners. In an eighth state, with an elective coroner system, the statutes provide that justices of the peace may view bodies and hold inquests. What may be the advantage of substituting the justice of the peace for the coroner, other than the elimination of a minor elective official, is not apparent. It would appear to be an admission that the work done by coroners in

other states is held to be of relatively little importance in those states where the justice of the peace does such work.

In Nebraska, the county attorney performs all the duties that had been enjoined by law upon the county coroner previous to 1917. In the state of Washington, the prosecuting attorney acts as coroner in counties with a population of less than 40,000. This is a distinct improvement over the usual coroner system. It places the important legal duties of the coroner's office with an official trained in the law. The medical duties are performed by physicians named by the county or prosecuting attorney, just as in most states a physician is selected by the coroner. The system is faulty in that it prescribes no qualifications for the examining physicians and provides for no definite period of service.

REFORM OF THE CORONER'S OFFICE

Reform of the American medicolegal system, in those of its aspects that have to do with the investigation of deaths, with the application of psychiatry to law, and with the presentation of expert medical opinion to tribunals, is imperative if the people of the United States are to have a system of judicial administration comparable in high character of work to that of the countries of continental Europe, of Scotland, of Egypt, of Japan, and of a number of South American countries. In so far as the work usually done by coroners is concerned, the way to better service has already been put into effect in a number of jurisdictions. The method of procedure in use in Nebraska and the state of Washington lacks only provisions for the appointment of qualified physicians and their continued service under conditions that will free them of political pressure to make that method practically identical with the medical examiner system that functions so excellently in Suffolk County (Boston), Massachusetts, New York City, and Essex County (Newark), New Jersey, and that does somewhat less better work in the rest of the state of Massachusetts and in the other New England states.

Under the medical examiner system, the examiner is an appointive official. He serves either continuously under civil service, as in New York City, or for a stated period of years, as in the other

jurisdictions. If appointed for a term of years he is reappointed repeatedly. The result is that in New York City, Suffolk County, Massachusetts, and Essex County, New Jersey, the medical examiners have served continuously for many years. Their appointment in the beginning having been based upon a knowledge of pathology, the value of their services to their communities through increasing experience gained by continued work in a technical field should be obvious. If the medical examiner's investigation brings to light anything suggesting criminality or negligence, he reports his findings directly to the district or prosecuting attorney, who makes the necessary further legal investigation of the case. Although the examiner reports his findings in criminal cases to the prosecutor, he is not influenced by political obligations to the latter, since the appointment of the medical examiner is not made by the prosecutor. The medical examiner system has the patent advantages of a simpler and more direct method of procedure in criminal cases and of expert medical service in all deaths that must be referred to some agency of government. It has the added advantage of modern laws drawn to meet contemporary conditions.

It is difficult to see how the coroner's office may be reformed short of complete abolition. The most fundamental reform that is necessary in the interest of better public service is the abolition of the inquest and the transfer of the coroner's inquisitional functions to the public prosecutor. Such a change would leave to the coroner only nonviolent deaths. The investigation of these is primarily a medical problem and should be made by medical experts. Action by a coroner would not be necessary in such cases. The medical expert could transmit his findings directly to compensation boards, registrars of vital statistics, health departments, or any other agency entitled to know the facts. Abolition of the inquest as a duty of the coroner therefore logically leads to abolition of the office itself and to the replacement of the coroner by the medical examiner.

The superiority of the medical examiner system in those populous communities where the system has been tried is without question. But this system has not yet been as well adapted to

the needs of less densely populated parts of the state as should be the case. Massachusetts abolished the office of coroner and substituted that of medical examiner in 1877. The two examiners of Suffolk County are on a fulltime, salaried basis. In the rest of the state the examiners are on a fee basis. Their number varies from one to eleven for each of the thirteen counties outside of Suffolk. This state-wide medical examiner system is a decided improvement over the antiquated coroner system, but it is not as well adapted to modern conditions as it might be, because at the time of its adoption the important rôle of automobile transportation in American life could not be foreseen.

A modernized state medical examiner system should disregard county limits, if this is constitutionally possible. Each medical examiner district of the less densely populated portions of the state should consist of several counties, the size of the district being determined by population, which is the factor that governs the amount of work that must be done, and by local transportation facilities. The cost of maintenance of such a medical examiner district could be prorated among the counties constituting the district. In a number of states two or more counties may unite in the construction and maintenance of a sanatorium for the treatment of tuberculosis. The cost of the care of indigent patients in the hospital of the state University's medical school is charged against the county from which the patient comes. A state medical examiner system composed of districts such as have been suggested would give to all parts of the state a much higher type of expert service than is possible under any other system.

To provide each examiner district of the state with all the laboratory facilities that might at times be necessary for thorough and scientific medicolegal work would probably entail a greater expenditure than the volume of work to be done would warrant. In a state medical examiner system in which the local districts are in charge of appointed and reasonably well trained pathologists, there should be a central state agency, to which local examiners might refer such materials as require microscopic, chemical, or other scientific investigation and such problems as

require highly expert opinion for their solution. The creation of such an agency in each state, for which the name medicolegal institute might be adopted, has been recommended by the American Medical Association and the American Bar Association.

Back of whatever medicolegal system that might be devised must be laws that clearly define the duties that are to be performed under the system and the authority for the performance of the prescribed duties. Such statutory definition must be made in the light of the needs of society as it is constituted at the present day.

PERMISSION FOR NECROPSY

I have been asked to suggest a form for a fool-proof necropsy permit. I am afraid that it will be impossible to devise a fool-proof permit until such time as our social organization reaches the millenial state when fools are no longer bred or developed. A wise man has said that any fool can start a civil law suit if he can get a knave of a lawyer to bring the suit. Whether he will win the suit is another question. But so long as fools and knaves exist, suits will be brought for the alleged illegal or unauthorized performance of necropsies.

Most of the suits of this kind that have been brought have been against coroners. The coroner needs no expressed permission to perform or authorize a necropsy. The statutes define the conditions under which he may exercise this important medical function. As has already been pointed out, difficulties arise because the statutes are not precise enough in their definition of authority. The coroner may find himself brought sharply to a halt by a court decision to the effect that he has overstepped the bounds of his statutory authority. The matter of legal permission for a coroner's necropsy requires little further discussion here. The question is one of what the coroner may do under the written laws relating to his office. He may not be able to find the answer to the question except through a court decision. The liability rests with the coroner who authorizes the necropsy, rather than with the physician who does the work under the orders of the coroner.

For the performance of a necropsy by another than the coroner, when no medicolegal problem is involved, permission is necessary. It is to be noted, however, that in only one state, Connecticut, is it necessary that the permission be in written form. In this connection it may also be noted that in one of the most important University teaching hospitals in the country, which has the high permission necropsy percentage common to such hospitals, no relative is asked to sign any form of permit. The attending physician signs a printed form affirming that he has received permission for necropsy from the person whose name and relationship to the deceased are written into the form. In the twenty-two years during which this method has been in vogue in that hospital, no difficulties have arisen.

Most hospitals, as a matter of protection, require that the permission for necropsy be in writing and be signed by a responsible person. While such a permit may not actually be necessary, there can be no question but that it protects the hospital against knavery and mendacity. It may not prevent the bringing of a law suit, but it may be the main factor in preventing the loss of the suit. When difficulties arise over the performance of a necropsy, permission having been actually given, they may arise out of any one of several factors.

The allegation may be made that permission was given by one not legally entitled to grant it. The person who may give permission to hold a necropsy is the one entitled by law to the custody of the body. In general, this is the surviving spouse or the next of kin. If there are several relatives of equal degrees of kinship, as two parents or several brothers and sisters, it would not appear necessary to have the consent of all such kin. The right of custody carries with it the duty of legal disposal. The relative who accepts the custody of the body and the responsibility of sepulture would appear to be the one who should sign the permit. An adult son of the deceased may set up the claim that permission for necropsy given by another son or daughter of the deceased is not valid, because it was not made with the consent of the complainant. In such instances, the controversy would appear to be among the kin themselves, rather than between a next of kin and the hospital or pathologist.

Suits have been brought on the ground that the person who granted permission and had a legal right so to do alleges that he did not know what he was signing when he affixed his signature to an autopsy permit. Such a claim would probably have little standing in a court of law if the hospital acted in good faith in the performance of a necropsy.

A more reasonable ground for complaint may arise out of the claim that the hospital or pathologist did not act in good faith when the permission for necropsy was obtained. It may be claimed that the autopsy permit was granted under a promise that the examination would be limited to such as might be made through a small incision. Interns have been known to obtain permission for necropsy under such a promise. The signature is affixed to the usual form, which places no restrictions upon the examination to be made. If the pathologist now proceeds with a complete necropsy, as he has the undoubted right to do under the signed permit brought to him, the promise made by the intern, as a representative of the hospital, has not been kept. A charge of bad faith is ethically justifiable. Certainly no blame attaches to the pathologist, who has acted in good faith. The liability of the hospital would probably have to be determined in each individual case, upon the merits of the case.

When the permission for necropsy has been obtained in an honest and straightforward manner and the necropsy is done with the care and decency that it deserves, few controversies will arise over alleged unauthorized autopsies. If chicanery or dishonesty has entered into the obtaining of the permit, or if the necropsy has been improperly done, there would appear to be some cause for complaint.

REMOVAL OF ORGANS AT NECROPSY

Pathologists do not hesitate to retain organs removed at necropsy. Any proper teaching of gross pathology is inconceivable if the changes caused by disease are not illustrated by organs removed at necropsy. But the right to retain such organs may be questioned. Upon this point Weinmann[6] has expressed the following opinion

If a physician performs an autopsy which he is legally authorized to do, either by the consent of the persons entitled to sepulture or by virtue of statutory authority, including direction from a coroner, such physician cannot legally remove and retain portions of the body unless such procedure is essential for determining the cause of death or for the determination of some other reason for which the autopsy was ordered or permitted.

Every pathologist will probably have to admit that he has retained organs for teaching or museum purposes, rather than that their retention was essential to the determination of the cause of death or the establishment of the nature of the disease process present. Permission for necropsy in non-medicolegal cases is usually given not merely for the purpose of determining the cause of death, but to elucidate the nature of disease and to further medical knowledge. The removal of organs would therefore appear to be permissible upon the ground that its purpose is the "determination of some other reason for which the autopsy was ordered or permitted" (Weinmann). The matter could be very easily covered by a clause in the necropsy permit authorizing the pathologist to retain such organs as he might deem necessary for further study. In general, however, the form used to grant permission for necropsy should contain as few qualifying clauses as possible.

DISPOSITION OF PARTS REMOVED FROM THE LIVING BODY

One of the essentials of an approved hospital, required by both the American Medical Association and the American College of Surgeons, is that all tissues removed by surgical operation must be sent to the laboratory for the proper examination. Hospitals seem to take it for granted that the disposal of removed tissues or parts in conformity with this requirement is a right of the hospital. Controversies sometimes arise between the hospital pathologist, who looks upon such surgical material as the property of the hospital, and the surgeon, who may insist that the specimen belongs to him.

The mere fact of the surgical removal of parts of the body does not make them the property of the hospital, the pathologist, or

the surgeon. Under the common law the living person from whom such parts are removed or his legal representative has the right to direct the disposal of tissues, organs or parts removed from the body. In four states, New York, North Dakota, Oklahoma, and South Dakota, this right has been enacted into statute law. In the three last named states the statutes are so worded as to make the laws relating to the dead human body applicable to removed parts. Enforced to the letter, these statutes might make necessary a burial permit for a pair of removed tonsils or a transportation permit for a specimen sent out of the state for histologic examination.

Few legal controversies have arisen out of this right of a person to direct the disposal of removed parts. But the element of trouble exists if a patient should choose to make trouble. Possible difficulties could be very easily obviated by including in the permit for operation, which most hospitals or surgeons require, a clause to the effect that the hospital or surgeon shall dispose of any tissues removed. In hospital cases, the hospital, rather than the surgeon, should have the right to dispose of removed tissues, in order that no controversies may arise between hospital and surgeon in complying with the requirement that all surgical specimens be sent to the laboratory for examination.

In the examination and disposal of stillborn infants, many hospitals proceed in a manner whose legality may be questioned. For the stillborn infant a certificate of stillbirth must be filed and a disposal permit must be issued. For the examination and disposal of a stillborn infant, permission is just as necessary as for the necropsy of a dead body.*

*Attention should be called to bulletin 83, by George H. Weinmann: A compendium of the statute law of coroners and medical examiners in the United States, Washington, D. C., National Research Council, 1931. pp. 240. This and bulletin 73, contain quotations from the written law and citations to court decisions that make them valuable sources of information when difficulties arise relative to the matters covered by their titles. When the physician encounters such difficulties, he should call the attention of his legal representative to these bulletins, since many attorneys-at-law do not appear to be familiar with the legal points involved.

SUMMARY

In the United States the application of medicine to law and justice, which may be said to constitute the medicolegal system of the country, occurs along several independent lines.

These are the investigation of certain classes of deaths, especially those which involve an element of criminality or negligence; the determination of the mental status and legal responsibility of those accused of crime; the determination of liability for personal injury or disease in accident and workmen's compensation cases; and the use of medical science in crime detection.

In the greater part of the United States the investigation of deaths, which is the aspect of the medicolegal system more fully discussed, is made by the office of coroner.

The obscure and political character of this office and the lack of clarity in the statutes defining its duties and authority combine to make the coroner's office an unsatisfactory agency in the administration of justice. There seems to be no very clear understanding, even upon the part of the medical and legal professions, of what the duties of such an agency should be and of what the needs of organized society are.

Of minor importance in rural communities, the office of coroner is a medicolegal and governmental agency that is called upon to perform a large volume of important public work in densely populated districts.

The coroner's office is not a necessary part of the American system of government, although the duties that it performs exist in every community. In a number of states the office does not exist, its duties being performed by the justice of the peace or the prosecuting attorney. In still another group of jurisdictions the coroner has been replaced by the medical examiner.

Reform of the coroner's office would require the transfer of the inquisitional duties of the office in criminal cases to the prosecuting, district, or state's attorney. In other cases the investigation to be made is medical in character. Abolition of the inquest would logically lead to abolition of the coroner's office and its replacement by the medical examiner system.

In a state medical examiner system, each densely populated county would require a single examiner's office. The less densely populated portions of the state should be subdivided into examiner districts, each comprising several counties. The size of the district should be governed by population, area, and transportation facilities.

In such a system there should be an agency maintained by the state, which might be known as a medicolegal institute. To such an agency medical examiners could submit materials requiring scientific investigation.

Certain problems relating to permission for necropsy, examination of stillbirths, and disposal of surgical specimens are discussed.

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THE MEDICOLEGAL NECROPSY

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This symposium by the American Society of Clinical Pathologists, a Society national in scope, upon the interesting and important subject of medicolegal investigation is of striking significance. I cannot conceive of a more fitting occasion to bring up such an important subject as the medicolegal necropsy. It is an opportune time to hold a symposium on these matters before a Society which is composed of trained and qualified clinical pathologists, familiar with laboratory work in its manifold aspects, and whose members have published valuable articles upon the clinical as well as pathological phases of medicine.

Some are probably not familiar with the post-mortem examinations of medicolegal cases; these have been handled by coroner's physicians, and in a few cities by a medical examiner. Specialism in medicine and surgery has grown enormously from necessity, and I do not hesitate to state that coroner's physicians, autopsy surgeons or medical examiners, to be thoroughly competent must be specialists, and by this term I mean that they should devote their entire time to this important sub-division of medicine.

That part of medicolegal medicine which concerns itself with the accurate determination of the cause of death, readily divides itself into two divisions. The first, and certainly for the medical profession, the most important division, is that which concerns itself with the cause of death, a strictly medical problem.

In the past this matter has been neglected. This neglect is traceable and involved in the evolution of medicine in our country. In the early days the physician served an apprenticeship with a physician or surgeon, and thus he slowly learned his medicine. Then there was a period of medical schools almost entirely pro-

prietary in character, followed by a period in which the splendid medical schools have been slowly evolved. Scientific research and all phases of medicine have made marvelous strides. But medicolegal medicine has not established itself anywhere in this country on a firm and progressive basis. The reasons for this neglect I may take up later in the discussion of the second division of my subject, namely, the legal or official status of the coroners and medical examiners systems of the country. Let me briefly state my conception of the qualifications of a medical examiner. The primary qualification is that he must be thoroughly versed in the practical side of pathology, hence, a long and varied autopsy experience. One of the most interesting of the problems encountered daily is that even after a thorough post-mortem examination we may be in doubt as to the cause of death. The pathologist who has had varied experience in hospital work of this character is, in my opinion, qualified to begin his task along medicolegal lines. He will, however, run across cases in which he will be puzzled, since his experience has not included just that kind of a case. To elucidate, when an unknown adult is found in coma, and there is no history connected with the death, and no previous medical history is available, frequently nothing is found which will indicate to an experienced man the cause of death. A thorough follow-up work is required. In a large city, most of these cases fall into the narcotic, the alcoholic, ethyl or methyl, and various poisons, over-doses from barbituric acid compounds, strychnin, and also very acute cases of sepsis.

After autopsy, the subsequent work entails chemic, microscopic and bacteriologic examination of the viscera and in homicidal cases examination of stains to determine if it is actually blood, and if blood, whether of human or animal origin as well as the examination for semen. Serological examinations may be necessary, involving the use of the precipitin reactions and also blood grouping tests which may lead to the identification of the person.

A little consideration will convince you that no one man is competent or able to perform alone what I have mentioned. However, the head of a department, the medical examiner of a county or of a city, should have enough experience to realize the

importance of the work at hand, sufficient knowledge to see that there is preserved enough tissue for chemical and microscopic examination. A prevalent belief is that all that is necessary is to retain the stomach content; an important test, of course, but alone it does not afford opportunity for making valuable observations and deductions which are necessary to elucidate a case of poisoning. Until absorption takes place from the stomach, the contents of the latter may be considered to be outside of the body. It is, therefore, of extreme importance to determine accurately and quantitatively, the amount of poison in the brain, liver, kidneys, et cetera.

The traumatic cases of a large city furnish the medical examiner with an enormous amount of material and the opportunity of making valuable observations and forming conclusions as to the circumstances of death.

Fat embolism plays an important rôle in the causation of shock following fractures of the large bones, and also it may be a cause of death. A valuable article by B. Morgan Vance[1] has called attention to the importance of this subject, and brought out the fact that while fat emboli frequently occur after trauma to fatty tissue, especially in the shafts of the long bones, that severe and fatal cases of embolism are exceptional, indicating that the protective mechanisms of the organisms work with sufficient efficiency to prevent the absorption of the fat into the blood stream in any considerable amount. He called attention to the fact that fractures of the bones of the extremities are most apt to produce fatal emboli but in his series of fifty-nine cases of fractures of the bones of the extremities, only three individuals died as a result of fat emboli. Finally, the author called attention to the difficulty in diagnosing the condition during life unless the possibility of fat embolism is kept in mind.

The post-mortem findings in casualty cases are essential, when it is borne in mind that death may follow casualties days or weeks after the injury. I know of no group of cases in which greater difficulties are encountered in forming a positive opinion and in arriving at a just conclusion as to whether the accident really had a determining action in the resulting death. It is unwise to

wear spectacles of prejudice and extreme care must be exercised that a preformed opinion is not entertained. The medical examiner must be unbiased in the opinion he gives to the grand jury, to the trial court, and to the compensation court.

Accident and compensation cases should be handled in a manner similar to that of the Central European countries, and Switzerland, where valuable dissertations and books upon traumatic injuries, the so-called Unfall Kunde, or Unfall Medizin have been published.

All vehicular accidents should be the subject of a careful inquiry. The statistics of the New York office show that in nearly 25 per cent of the deaths from such accidents which take place shortly after the injury are found to have been in persons drunk at the time of their death. No special emphasis need be placed upon the important judicial aspects of this finding. In the past, great injustice has been borne by perfectly innocent drivers who have run over drunken people crossing against the traffic lights of a busy city, or during the early hours of the morning.

Many vehicular accidents are due to accidental falls by persons suddenly taking sick with vertigo or who are partially blind, and a thorough examination is required. The French have called attention to other classes of traumatic accidents. Deaths from occupational disease requires a long review. Let it suffice to call to your attention lead poisoning, acute and chronic, mercury, benzine, and the brilliant work of Dr. Harrison S. Martland upon radium poisoning, which is unique and a classic.

What are the measures to be adopted to improve the administration of medicolegal procedure? The members of our Society are admirably suited to perform the preliminary work of improving the situation. The problems presented by a large city differ considerably from those of smaller cities, towns and counties. The organization of a large city where volume has to be taken care of is more difficult, and yet the problems presented in small cities or counties are similar, and careful autopsy work must be performed by competent pathologists and follow up work along the lines I have indicated in chemistry, pathology and bacteriology.

I suggested a number of years ago that in small counties a hospital pathologist and the health officer might assume the rôle of medicallegal experts. Although the suggestion is a workable one, there are immense difficulties since throughout the country the coroner's physicians are appointed largely through political influence. The politicians or our rulers have no appreciation of the work involved and many of them do not consider the work necessary. Any progress or change suggested will be considered the work of a reformer, who is despised because he upsets the status quo.* Let us contrast the system prevalent in this country with the Central European countries, Germany and Austria, where for decades a hereditary intelligence has prevailed and high standards have been enforced. The people recognize the necessity of a thorough investigation of crime and of disease. The investigators are state officers with University training and experience and are appointed by the University. Before appointment to an important post they have served many years as full time assistants of experience. The work is supervised closely by the court, as to the form in which their reports are written, and in smaller towns and cities where the reports are made by less well known experts, they are subject to revision by superior experts appointed by the court to serve. In cases where the report is insufficient for the court, or for a reviewer to come to a decision, an exhumation is made, and another necropsy is performed. There are well-known legal institutes in which interesting cases are worked up, published either in the general literature or in the separate publications of the institute of origin. A continuous progress in the science of medicine is established. The Medicolegal Institute of Vienna publishes the "Beitrage zur Gerichtliche Medizine," of which Professor Dr. Albin Haberda is the editor.

*Too frequently we let past conditions control our present thinking. To quote from John M. MacInnis: "One of the great menaces to real democracy is that political interest and activities are frequently left to selfish exploiters who look upon politics as an opportunity to advance their own interest and feather their own nests. The fault lies in the men who are not willing to subject their personal interests to the larger interests of society and to give the state the time and service that are essential to good government.

We have nothing comparable to these institutes. Recently, an Institute of Forensic Medicine was established in New York City with meager funds, a praiseworthy effort on the part of New York University, and the Bellevue Hospital Medical School to improve conditions. Much is required to establish an institute of this kind according to modern standards. An animal plant with trained keepers, assistants versed in serology and bacteriology, enough section cutters and laboratory men to perform the necessary work in pathology, as well as in chemistry. A plant of this character requires of its workers much time, and money is necessary. In a large city the medical examiner and his assistants should be full time men without any other interest. Under the existing circumstances, it is not possible to demand from medical examiners that they be full time men because of the low salary paid to them, and the dread hanging over them like the Sword of Damocles that they may at any time be removed, and thus placed in the position in the future of not being able to obtain their living by the practice of medicine.

In Europe the need for money and advancement along the social scale, so-called, is not as urgent a one as in our country. I think you will be able to read my thoughts, namely, that the great obstacles to progress lies in the lack of understanding and education of those in whose hands our fate lies.

In a discussion of medicolegal medicine, it is well to bear in mind that the functions of the coroner's physician, autopsy surgeon or medical examiner, is purely investigatory. There is no need of entering into further detail as to what the essentials of these officers are. The autopsy must be performed by thoroughly trained and competent microscopists in a laboratory capable of running through and sectioning tissues for examination. Also a competent chemist with assistants and suitable apparatus and a bacteriologist who is familiar with the details of his work as well as one familiar with blood examinations. Without this, there is no progress, and the conclusions to be drawn from an incomplete necropsy are almost wholly untrustworthy, and grotesque failures of justice have been recorded from these.

A medical examiner must have training in the examination of

scenes, of the body or bodies found there, the examination of the clothes of the subjects of homicidal assault, the presence or absence of powder grains, also a working knowledge of fire-arms, the distance at which a gun may have been held, and also if the clothes have more bullet holes than correspond to the number of entrances and exits from the body.

Chemical examination for chloral, chloroform and alcohol should be made in all homicide or suspicious deaths. A complete record of the scene and of the autopsy and the subsequent work is essential for use in a trial.

The profession represented by the medical examiner must be authorized to determine the cause of death of any cases under his jurisdiction by necropsy when he deems it necessary. Lawyers and coroners are not qualified to determine this question as it is a strictly medical one. Fortunately, in New York, we have complete authority and we do not have to ask permission from any one how we should handle any given case. In some states the District Attorney is the one to be appealed to for permission. A ridiculous situation, since it is a strictly medical problem. Many jurists believe that the cause of death is objective, that an autopsy should cease, for instance, when the cause of death has been supposedly reached, seeming to hold the view that the cause of death is an object, to be removed from the body when seen.

What is meant by the cause of death? Too little attention has been given to the scientific aspects of this problem. For instance, how commonly we hear that a man has died from a fracture of the skull. A fracture of the skull does not cause death in itself. Often the inaccuracy of statement by an expert may lead to serious injustice. The teaching of applied and experimental physiology should always be invoked. The rapidity of death following injury—how far can a man walk or run after being shot—these determinations are not always readily ascertainable. But a little knowledge of physiology may serve to elucidate the case for the judge and jury. I do not wish to enter into any discussion of the relative merits, and demerits of the coroner against the medical examiner system. It seems to have been overlooked that the masters of forensic medicine, Taylor and others in England, have

for the last eighty years been decrying the archaic system of the coroners in England.

Truth compels the conclusion that glaring deficiencies exist in the administrations of the coroner's as well as the medical examiner's system of the country. The remedies are known, but not easy of application, for the treatment is not entirely in our hands. Experienced pathologists in control with well equipped laboratories and sufficient clerical forces, stenographers and photographers are indispensable.

The second division of the talk may be made very briefly. First, educate the public and our legislatures to the importance and extent of the subject of medicolegal investigation.

Second, teach the value of the necropsy. A well planned campaign to overcome the prejudice of the public to examination of the dead is necessary. The medical profession is somewhat responsible for the antagonistic attitude of the public. The contrast between our country and the central European countries is noticeable in this regard. To illustrate, all the professors who taught me during my post-graduate studies in Vienna were thoroughly examined after death. There is very little racial prejudice to post-mortem examination except among the orthodox Hebrews.

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PERFORMING THE MEDICOLEGAL NECROPSY

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The medicolegal necropsy, in accordance with the laws of most states, embraces those cases of death which may have been induced by homicide, suicide or accident. Due to the latter, it must at once become apparent that a great many medicolegal necropsies come within the purview of the compensation laws of the various states, opening and embracing the relatively new field of occupational diseases and injuries.

For purposes of simplification, medicolegal necropsies may be classified into the following six major groups:

(1) Crimes of violence (shooting, strangulation, stabbing, infanticide, et cetera)
(2) Sex crimes (rape, et cetera)
(3) Poisonings (including homicidal, accidental, occupational)
(4) Traumatic accidents (automobile injuries, falls, et cetera)
(5) Still-births, malformations, birth injuries
(6) Sudden (accidental) deaths

Modern criminal society, as depicted by the gunman, racketeer and other perverts of humanity, leans much more to the quick violent method of death, that is, shooting, stabbing, strangulation, et cetera, than to the ancient "fine art" of the poisoner's hand, an art they have relegated to the limbo of the past.

The medicolegal necropsy, while demanding astute knowledge and care on the part of the pathologist in establishing the cause of death, requires much more than a painstaking necropsy. A well trained medicolegal pathologist can be of inestimable service to the police officers at the scene of death. The position of the body, the instruments causing death, the condition of the surroundings, the presence of a box or of a bottle, the odors in a room —all are of importance in arriving at a conclusion as to the cause of the individual's death.

When the pathologist is ready to proceed with the examination of the remains, having first satisfied himself as to the identification of the body, either by a relative, friend or the police officer, he should begin with a minute inspection of the external body, dictating to a competent stenographer as he proceeds with his findings, both negative and positive. It is absolutely necessary to have an identification of the body, and dictation of the findings must be made as the necropsy proceeds in order to be competent evidence, although, of course, correction of a draft of a protocol is permissible. During the inspection, the examiner must always bear in mind whether a lesion is antemortem or postmortem and whether it may or may not have been self-inflicted. All bodies must be measured as well as weighed. For the latter an ordinary platform scale is suitable. All the organs must also be weighed and for this purpose an ordinary dial scale or the usual grocer's balance is satisfactory.

The external inspection of the body is probably of greater importance in the majority of medicolegal cases than examination of the remainder of the body, since most criminal deaths at the present time are crimes of violence which leave external evidences, rather than the more subtle methods of poisoning. This subject is, therefore, dealt with in some detail. It is well to conduct the inspection in an orderly manner, commencing with the hair on the scalp. The condition in which the hair is found should be noted—its texture, color (dyed?), blood or other stains or admixtures, et cetera. The condition of the scalp should also be noted, especially for wounds, hemorrhage, et cetera. The eyes should be examined with particular regard to the state of contraction of the pupils and the opacity of the cornea and lens. The ears, nose and mouth should be examined for discharges (blood, pus, et cetera). The condition of the teeth, tongue, and other mouth parts should be noted. Rigor mortis, discoloration of or marks on the skin, surface temperature, should be noted. Puncture marks or old needle scars, especially in the arms and thighs, may be of value in directing the examiner's attention either to a case of poisoning or drug addiction.

Careful inspection of the entire body should be made for ec-

chymoses, injuries, wounds, scars, fractures, and anomalies. Very often a bullet wound made by a 22 calibre gun may be overlooked. In the case of bullet wounds, the condition of the surrounding skin should be searched with a magnifying lens for powder marks, and burns. Search for the wound of exit must be carefully made. Knife wounds or lacerated wounds of any kind should be carefully examined as to their nature, size and direction, since the latter particularly may yield a clue to injury to an internal viscus, the position of the assailant, and the appearance of the wound may give an indication of the type of instrument used. Often a syphilitic scar on the penis or extremities may be a clue to a natural death which had been thought at first to be of a suspicious nature. Ecchymoses may often aid in interpreting the position in which the individual dropped at the time of accident or injury. Ecchymotic areas about the neck with edema of the tissues, tongue, and other parts of the head and neck, and imprints of fingers may indicate strangulation. Rigor mortis, the temperature of the body, and the clearness of the lens are, within reason, relative points as to the time of death of the deceased. The determination of temperature is a very variable factor, depending upon the temperature of the place in which the individual was found, whether he had a fever just prior to death, or whether other conditions pertain. In general, however, it may be said that the temperature drops one degree for every hour post mortem until the surrounding temperature is reached. The opacity of the lens and cornea is likewise a variable factor, depending on the age of the individual, his state of health, the condition of his eyes, and other general and specific conditions, but here again it may be taken as a rough index as to when death occurred. In general, whenever a haziness is found in the cornea, it may be said that death ensued at least twenty-four hours previously.

It is advisable to finger print the individual, not merely as an aid to the identification of the deceased, but to compare the prints with others obtained at the scene of the crime (or accident) or with those attained on previous occasions. Finger printing has been adopted as a routine procedure in most of the European

countries, since it is used there as a method of identifying anyone. It is to be hoped that an enlightened people will insist that similar laws be adopted in the various states of this country.

Frequently anomalies (supernumerary fingers, toes, et cetera) or peculiarities of the individual may be found, especially in the upper extremities. Thus, an exostosis of the index or middle finger may be the result of the position in which the individual held his pen or pencil and this may be an aid to identification.

Examination of the teeth and even dental impressions are of value, especially for purposes of identification, and a chart such as is used by every dentist should be included in the records of the case, especially if the deceased is unknown.

Although most postmortem rooms are not equipped with x-ray apparatus, it nevertheless is often desirable to take complete pictures of the corpse, and facilities for x-rays and photography should be provided. This is of especial value at times in locating a bullet, in revealing a fracture, and for other purposes.

The question of sudden death from natural causes is one which the medicolegal expert will constantly encounter, and it is well to bear it in mind. Of paramount importance is the so-called status thymico-lymphaticus death. This condition has frequently been the subject of considerable dispute. Only recently a prominent German pathologist questioned the relative importance of status lymphaticus as a cause of death. He based his opinion on postmortem observations made during the late war, in which he claims that no cases of "status" death, or one in which status lymphaticus played a rôle in the cause of death, could be found. However, every experienced pathologist, we are sure, has encountered bodies showing the characteristic anatomic landmarks of status lymphaticus and presenting ruptured hypoplastic vessels, and other conditions associated with this condition.

In addition, one must bear in mind the cases of sudden death without any recognizable lesion. Among these are included true angina pectoris, deaths from shock or syncope, anaphylactic death, diabetic coma, insulin shock, and acute ethylism. Of these types, some may at times be difficult or even impossible of recognition or explanation at the autopsy table. We refer especially

to anaphylactic deaths from foreign protein sensitization where the foreign protein is of such minute amount that it is impossible of detection by our present chemical methods, or, as with excessive doses of insulin, the injected substance is quickly metabolized.

A miliary embolism, edema of the glottis, or a foreign body in the larynx or trachea, are lesions causing sudden death that are frequently overlooked.

Finally, it may be said that sudden death in the young is generally caused either by a disturbance of the nervous, respiratory or intestinal systems or by status lymphaticus. On the other hand, in adults, lesions of the circulatory system are of the greatest importance.

It is not the object of this paper to discuss the various methods of conducting an examination of the interior of the body, since this must be dependent upon each individual's tastes and training and the purpose for which the examination is made. The incisions employed in opening the body cavities may be varied. In the usual procedure, an incision is made commencing either at the suprasternal notch or under the lower chin and terminating at the symphysis pubis. Latterly, in attempting to conform with modern dress, we have, especially in females and sailors, made a V-shaped or elliptical incision, commencing under the breasts and running to each shoulder joint. This is dissected upward and forms a complete flap which, when sutured, is not visible after the body is properly clothed. This incision connects with a median incision just below the breasts and extends to the symphysis pubis.

After the body is opened and note made of the panniculus adiposis and the condition of the muscles, the peritoneal cavity is examined. The position of the omentum and of the abdominal organs in situ is noted. Examination is made for fluid, gastrointestinal contents, blood, tumors, inflammatory exudates, tubercles, et cetera. The pelvis is inspected and the height of the diaphragm noted. Frequently a ruptured or perforated viscus causes blood, bile, stomach or intestinal contents to be found in the abdominal cavity. Bullets, gall-stones or enteroliths may be

found in the abdominal cavity. Lesions due to fat necrosis from an acute hemorrhagic pancreatitis may be scattered throughout the cavity. Pus beneath the liver may be found secondary to a comparatively mild inflammation of the appendix. A gangrenous omentum or piece of strangulated intestine or a mesenteric thrombosis may be encountered. Bleeding from a small wound in the liver or spleen may result from a perforation by a rib caused by compression or a fall. Frequently such abdominal viscera as the liver, spleen, stomach, kidney, or bladder, are ruptured by an automobile or other heavy vehicle passing over the abdomen. Ruptured viscera, particularly the stomach, have been found in infants and young children following a simple convulsion. A ruptured spleen and fatal hemorrhage from a fulminating malaria or leukemia is not unknown.

It is not our intention in this paper to discuss rape, criminal abortion, postpartum sepsis, and other criminal deaths in detail, since these constitute one of the most difficult and controversial chapters in the entire history of medicine and have been the object of discussion and argument since the dawn of civilization. However, several cardinal points must be kept in mind. In the question of rape, the presence or absence of a hymen or a lacerated hymen must be sought, and, in young children, a lacerated perineum is, as a rule, mute evidence of rape. Smears from the cervical os or from the vagina may show the presence of spermatozoa, but care must be taken not to mistake parasites (*Trichomonas vaginalis*) for the former. In cases of criminal abortion, the impress of a tenaculum in the cervix, together with recent lacerations of the cervix, may be considered as presumptive evidence of abortion. The presence of a corpus luteum together with the gross and microscopic finding in the uterine wall of the placental tissue reaction is conclusive evidence. In this connection, it is desirable to call attention to a case which illustrates the importance of routine toxicological examinations in legal medicine.

A body came to necropsy in which abortion was suspected, the patient having died in the abortionist's office. The latter stated that the patient had come for an examination and died in his

examining room. At necropsy, the uterine contents were almost intact; there were, however, tenaculum marks on the cervix and sufficient separation of the placenta to cause fatal hemorrhage. The remainder of the postmortem examination was negative. Chemical analysis of the viscera revealed very large amounts of chloroform, and particularly in the brain. The abortionist was convicted and sentenced for manslaughter on the evidence of criminal interference with pregnancy, the presence of chloroform and fatal hemorrhage.

Continuing the examination, the next step may be the removal of the intestines and any or all of the abdominal organs for preservation as evidence, or for further study. Frequently cultures, smears, chemical and microscopic examination of the contents of the cavity, and particularly of the stomach, intestine, liver and kidneys, must also be made.

The sternum and costal cartilages are next removed and an orderly inspection of the thorax and its contents is made. After the thymus is inspected and removed, it is perhaps best to examine carefully the pericardium and its contents, since a stab or small calibre bullet wound frequently leaves very little evidence in the pericardial wall. On the other hand, the slightest injury to the heart or great vessels causes a hemopericardium. Before the heart is removed, its anterior surface should be inspected for injuries. Then the pulmonary artery should be incised in situ so as not to overlook a pulmonary embolus. Following this, both thoracic cavities should be examined for blood, pus, fluid or other foreign material. The heart is examined next on its posterior surface, after which it is removed, opened and examined. If an aortic aneurysm is present, it may be well to remove the lungs so that the heart and aorta may be removed en masse. In this connection, a coronary thrombosis or a ruptured aneurysm or ruptured aorta may be of the utmost importance. The state of the blood, whether it has undergone postmortem coagulation or is more or less liquid, should be noted, since, in cases of poisoning (alcoholism, gas, and under certain other conditions), it is, as a rule, more or less liquid. The lungs are next removed and in new-born or still-born children should be immersed in a basin of

water to determine if air had ever entered them. The lung, all its bronchi and the vessels should be examined. Small bronchial tumors, water or other fluids, foreign bodies in the bronchi, abscesses or pulmonary emboli are easily overlooked. The mediastinum must be examined, particularly for tumors, dermoid and echinococcus cysts.

The larynx and trachea must be removed and inspected. Frequently sudden death in an alcoholic individual may be explained by a particle of food obstructing the larynx and not by any excess of alcohol. In the case of a child found dead in bed, necropsy disclosed the presence of a lead pencil which completely obstructed the larynx and caused edema of the glottis. In this connection, it is important to call attention to the possibility, especially in children, of a diphtheritic membrane obstructing the larynx. Edema of the glottis following trivial injury to the neck or mouth must not be overlooked.

The esophagus must be split open and examined. Pin-point perforations may explain a suppurative mediastinitis or pleuritis, and larger openings may account for food contents in the thoracic cavity. Ruptured esophageal varices likewise may explain a fatal hematemesis. The thoracic duct must also be examined for perforations from bullets, stab-wounds, and other wounds, and rupture as a result of trauma or disease; particularly tuberculosis, must not be overlooked. The organs of the neck—lymph nodes, tongue, thyroid, et cetera—must also be inspected. Of great medicolegal importance is a fracture of the hyoid bone and thyroid cartilage leading to suffocation.

The skull requires most painstaking observation. Wounds and ecchymoses, of the scalp are of importance. The measurement of the cranial diameters and general shape and contour of the skull should be noted. The scalp as a rule is reflected by incising it, commencing behind one ear and bringing the incision across the cranial vault to end behind the other ear. The flaps are then reflected anteriorly and posteriorly. The cranial surface is next examined for hemorrhagic areas, fractures and other injuries. The skull is then opened by a circular incision through the occipital protuberance and about midway through the frontal

bone. After removal of the skull cap, the external dura is inspected, especially for pachymeningitis and for traumatic injuries. The dura mater is next removed and its inner surface inspected for similar lesions. The surface of the brain is then examined and the ogan is carefully removed in its entirety, cutting off the cord as low down as possible. The vessels at the base of the brain are then examined, especially for aneurysms, thrombi or emboli. Next the brain is opened by incising the lateral ventricles. The quantity of fluid, the condition of the choroid plexus, the ependymal surface, and the presence or absence of blood is noted. All the ventricles are opened and their surfaces inspected. The condition of the pineal gland should be noted. Following this, the brain is cross-sectioned and any change in the consistency of the brain, its vessels or covering noted. The cerebellum is likewise sectioned and the medulla opened by multiple incisions. The dura covering the base of the skull must then be examined and removed. Following this, the floor of the skull must be inspected for fractures and penetrations. The foramina and their contents should also be examined. Next the middle ears are opened by perforating the petrous portion of the temporal bone, and careful examination is made. Similarly the pituitary gland is removed and entry is obtained into the sphenoidal, frontal and ethmoidal sinuses. The orbital cavity may be opened and examined and the eyes also, if it is desired, may be removed in this way.

The spinal cord and, for that matter, the brain may be removed before the rest of the body is opened, but as a general rule this procedure is left until last. The cord is removed by a long longitudinal incision over the spinal column and the latter is usually opened by sawing through the lateral spinal processes. The spinal dura is next inspected and the nerves running from the cord should be examined. The cord is then removed, as a rule, in its entirety. In general, it is safe to say that the cord is usually relatively free from injuries except that now and then a bullet may penetrate its massive encasement, or a violent accident may cause a fracture of one or more of the vertebrae followed by compression myelitis. The cause of rapid, otherwise unexplain-

able deaths, especially in children, may be found in the cord, in the form of a fulminating anterior poliomyelitis, though this may generally be observed in the medulla oblongata.

It may be necessary to incise and examine the extremities when there have been fractures or in cases in which osteomyelitis, tetanus, gas-bacillus infection or a cryptogenetic sepsis has induced a fatal outcome from an otherwise trivial injury.

In conclusion, while only a brief and sketchy outline of the average medicolegal necropsy has been given, it is hoped that sufficient interest has been aroused in those pathologists who are called upon to perform medicolegal work, that they will seek further in this most important and difficult field of pathology. It must be recognized that a tremendous responsibility, namely, the life or death of an accused, at times rests solely and squarely upon the shoulders of the medicolegal expert and in the result of his findings and the opinion that he renders. The medicolegal pathologist can perfect himself in this work only by continued experience, careful analysis of his findings, and constant study of the literature, which is vast, indeed, and increasingly so, though, unfortunately for many, chiefly in foreign languages.

The importance of careful and painstaking examinations and analyses carried out with an open mind, not swayed by emotional outburst of press or public, or clouded by preformed conceptions gathered from similar cases, must be stressed. The medicolegal expert must be well trained in all fields of general pathology, including serology, and bacteriology, but especially in pathological anatomy, so that he can recognize a non-medicolegal death. In addition, he must have obtained theoretical as well as practical knowledge in medicolegal work. Such knowledge and experience are difficult to obtain at present in this country, since few schools give even the barest outline of what constitutes a medicolegal case. It is hoped, however, that an awakening conscience on the part of physicians will lead to greater attention to this difficult branch.

PATHOLOGICAL ANATOMY OF DEATH BY DROWNING

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To correctly interpret the lesions found in the body of a drowned individual, one must be well versed in the mechanism of death, clearly visualize the rapidly ensuing phases of struggle and defense of the submerged victim against overpowering forces, and have in mind the possible pre-existing pathological affections of the internal organs, particularly of the lungs and heart.

The post mortem examination represents only one phase of the investigation, where a question is raised as to whether or not an accidental, suicidal, or homicidal drowning occurred. Incidentally accompanying circumstances and many other conditions and situations must be thoroughly investigated and considered and then carefully correlated and evaluated.

My discussion is limited to the pathologic anatomy and to the differential diagnosis at the necropsy table.

Death by drowning, if uncomplicated, is a genuine asphyxial death, with occurrence of phenomena so commonly observed in this type of unnatural death.

APPEARANCE OF THE RESPIRATORY ORGANS

When the thoracic cavity is opened routinely, the lungs of a drowned individual do not, as they do under ordinary situations, recede or partially collapse, due to atmospheric pressure; but, on the contrary, they appear greatly distended, inflated, and their anterior margins either reach or even trespass the mediastinal midline, overlapping one another. The voluminous lungs completely fill up the space allotted them in the bony cavity of the chest, pressing against the ribs and pushing the intercostal spaces outwardly and the mediastinal pleura medially. The front bor-

ders of the lobes are not thin and sharp, but are well-rounded, and the basal edges exhibit this same appearance.

In observing the pleural aspect of the lungs, one does not meet with an even and smooth outer surface, but notices slightly projecting, prominent areas of a lighter color than the rest of the lung, often decidedly lobular in distribution, resembling an acute compensatory emphysema. Markedly distended air vesicles are readily discerned through the pulmonary pleura on the external aspects of the lobes.

The imprisoned, compressed air may be forced, through microscopic tears of the alveolar walls, into the interstitial frame of the lung, and then small air bubbles appear in a rosary-like arrangement beneath the pleural membrane.

Irregularly scattered patches of a suggested hemolytic imbibition are not uncommonly seen through the pleural covering, but pleural ecchymoses are rarely encountered.

The spasmodic, deep inspirations and the obstructed and insufficient exhalations finally lead to a marked or extreme ballooning of the lungs, the extent thereof depending upon the duration of the respiratory efforts. The volume of the retained air in the lung may exceed, by three to four liters, the amount present in an average lung. The degree of emphysema resembles in a certain way that found in fulminant types of acute diffuse bronchiolitis. Asphyxiation quickly sets in. One may ponder upon whether carbon dioxide saturation of blood exerts an ominous influence upon the vital centers of the medulla oblongata, contributing in causation of death.

In different individuals, the degree of sensibility and reflex reactions of the pharyngolaryngeal mucosa vary considerably and play an important rôle when any kind of foreign material encroaches upon these structures. The defense mechanism is accordingly influenced, namely, it is lowered or increased. If the first is true, water will rush into the respiratory organs, shortening the fatal period of struggle, while the individual possessing prompt reflectory responses will survive a longer time, in spite of the fact that he is caught defenseless in the drowning medium.

PULMONARY EDEMA COMPARED WITH WATERY LUNG

The lungs are not quite as heavy or as doughy throughout as they are in an edema resulting from other conditions, as seen, for instance, in cases of gradually failing function of the left side of the heart (transudation due to passive congestion). The consistence of the pulmonary tissue is not uniform, the dependent parts possessing a more pronounced doughy-elastic character. When one presses the lung with the tip of the finger, a circumscribed, sluggishly-disappearing depression results, similarly to that in edema of the ankle.

The cut surfaces of the lungs exhibit changes which can be differentiated without difficulty from other types of edema, such as cardiac, inflammatory, toxic, or certain asphyctic edemas.

While the volume of a normal lung is reduced when the organ is sliced with a knife, because of escape of air, and the parenchyma sinks below the level of the incised pulmonary pleura, the cut surfaces of the lung of a drowned individual do not retract.

The fluid quantity is considerably less than in a transudative or congestive type of pulmonary edema, only a small or moderate amount of frothy, clear fluid exuding. The same observation is also made when one compresses the incised lobe laterally and notes the comparatively small amount of expressed fluid oozing upon the cut surface. The drowning fluid forcefully and rapidly penetrates into all the structures of the lung and cannot be liberated easily.

The pulmonary parenchyma is more or less pale, except for hypostasis found in the dependent parts, and is not cyanotic and edematous as, for example, in cardiac congestion and edema, the moisture being comparatively far less pronounced, as mentioned before. The degree or intensity of the cadaveric hypostasis depends, of course, upon how soon after death the body was removed from the water and examined.

Prominent areas, identical in appearance to the projecting, patchy areas of emphysema visible on the pleural aspect, are also evident on the sliced surfaces. The air caught within the air vesicles during the dyspnoic stages distends the alveoli to a high

degree and does not always and in all places allow the invading fluid to enter them.

BRONCHIAL MUCUS HYPERSECRETION

The penetrating fluid acts as an irritative agent upon the entire mucous lining of the bronchial tree, causing congestion, and a hypersecretion of mucus, intense in character, ensues simultaneously. It is because of this fact that slimy material is so prevalent in all the respiratory tubes and that mucous shreds are found far down, within even the smallest bronchial branches. Small threads or minute clumps of mucous matter are noted quite regularly, but in varying quantities, in the liberated fluid obtained from the cut lung tissue.

Drowning fluid may or may not be present in the upper respiratory tract, depending upon the position of the body, handling during and after removal, artificial respiration, et cetera. If present, it contains finely distributed, minute air bubbles and slime. A clear froth, oftentimes abundant in amount, is seen at the nasal openings and mouth, and either partially or totally fills up the pharyngolaryngeal space, the trachea, and the main bronchi.

FOREIGN BODIES IN DROWNING FLUID

Should the drowning medium be turbid, colored in some way, and contain tiny or some barely distinguishable particles of vegetable or animal matter or origin, the fluid exuding from the lungs will be similar in appearance and the larger foreign bodies contained therein may be detected even by the naked eye. Frequently, such particles are seen sticking loosely to the mucous surface of the trachea and bronchial ramifications.

Microscopical analyses of the fluid scraped from the cut surfaces of the lung and of the medium in which the body was found should never be omitted, since in cases in which the autopsy does not yield positive or conclusive findings, such comparative microscopic examinations must be resorted to as the main means of establishing a correct diagnosis. But one should thoughtfully consider the fact that only presence of such particles in the

bronchioli and within the air sacs, occasionally within the interstitial tissue, is conclusive of their having been aspirated during life, since foreign bodies may arrive in the bronchial branches, even in the small ones, after death, especially if the body was immersed in deep water or in fluid medium under pressure, or if artificial respiration was applied.

ATYPICAL CASES

The findings mentioned above are met with in ordinary or typical cases of drowning, when examined soon after death and in which the lungs were not affected with chronic or acute conditions of any kind before. Pre-existing pathological changes may considerably change the entire picture.

This is particularly true in instances of firm fixation of the lungs to the thoracic wall as a result of an old, healed pleurisy. If the lung presents adhesions over only a circumscribed area, one may notice that the pulmonary tissue corresponding to that area does not show changes as described; the contrast between the findings in this adherent part and in the non-adherent portions of the lungs is clearly obvious, upon comparison. Such differences in gross appearance are even more striking in cases of total unilateral adhesion of the lung, since the fixed lung does not show findings of such a typical nature as does the freely movable, healthy lung. A comparison of the two illustrates this point very distinctly.

A pre-existing chronic pulmonary emphysema may confuse one in interpreting the significance of that condition. A critical weighing of this with the other enumerated points will aid one in differentiating it from a recent ballooning of the lung due to the effect of drowning.

Putrefaction may completely alter all the signs significant of death by drowning, and in advanced stages the diagnosis is rendered quite impossible. The thoracic cavities then contain a considerable quantity of a dark hemolytic fluid which had transuded from the lungs, and the costal pleura becomes hemolytically discolored throughout. The lungs appear small, collapsed, and present well-developed cadaveric changes. The frothy condition in the

air passages, a sign so characteristic of drowning, completely disappears. Cadaveric hemolytic processes discolor all the tissues.

POST MORTEM ENTRANCE OF FLUID

A post mortem penetration of fluid into the lungs may cause them to become heavy and quite moist, thus simulating to a certain extent the anatomical picture in cases of actual drowning. But, the emphysematous component, the ballooning of the lungs, and the fine frothy contents in the bronchial tubes are absolutely missing. Every single detail must be thoughtfully noted and cautiously reckoned with in order to avoid an erroneous interpretation and conclusion.

MUSCULAR HEMORRHAGES

A particular condition, which may have a certain criminalistic significance, is presence of hemorrhages in the soft tissues of the neck, within or between the muscles of the neck, for instance, involving the sterno-cleido-mastoid, sterno-hyoid, sterno-thyroid, et cetera. Occasionally, such hemorrhagic infiltrations may develop within the pectoral muscle or in the muscles at the nape (trapezius). These hemorrhages are not the result of any external violence but occur on account of minute tears of muscle fibers during the dyspnoic and asphyctic stages, which cause spasmodic muscular contractions (tonic and clonic convulsions), especially flexion of the head. Plainly visible lacerations of such muscular groups are seen in frozen bodies and are often artificial effects from handling the dead body.

If such muscle hemorrhages are detected, a strangulation should not be summarily assumed, or rejected. A close inspection of the skin of the neck for presence of marks of constriction is imperative. A dissection of the neck organs should follow, in order to ascertain whether injuries to the laryngeal structures or to the hyoid bone occurred. Evaluating the results of these examinations and considering the location of the muscular hemorrhages found, particularly if they are developed distantly from the laryngeal region, will safeguard one in deciding whether ante mortem attempts at strangulation were made.

SKIN PHENOMENA

Usually the entire surface of the body appears very pale and anemic because of contraction of all the peripheral blood vessels. Shock-like phenomena may occur, particularly in individuals susceptible to effects of cold water (urticaria-like reactions in the clinical picture). The blood is rapidly forced into the abdominal organs, flooding the splanchnic territory. This might explain certain instances of rapid, apparently sudden death in persons unexpectedly submerged, on account of anemia of the brain and inhibitory reflex actions. At autopsy, one may, accordingly, find indications of such an event.

It is a general belief that "goose-flesh" (cutis anserina) is commonly found in cases of drowning; however, it has no diagnostic value. It is indisputed that cold water will produce it during life. But, "goose-skin" may develop after death as a result of rigor mortis of the arrectores pilorum muscles. I have often caused it mechanically by stroking the skin of the body after death with the tip of my finger or with an instrument, and have produced it up to eight hours after death, which phenomenon gradually subsides together with the disappearance of the mechanical contractility of the skeletal muscles.

The skin of the palmar and plantar surfaces shows, after several hours of immersion, a bleached and coarsely wrinkled appearance, proving only that these parts of the body were in water for some time, either before or after death.

If wounds or bruises are detected, their ante mortem or post mortem character must be established and their origin, in correlation with circumstances under which the body was found, logically explained.

OBSERVATIONS OF OTHER INTERNAL ORGANS

The heart is flabby, as a rule, and its right side is dilated and filled with a dark-red fluid blood. As in some other types of asphyxial death, the blood does not clot. The drowning fluid, which is rapidly absorbed into the system, leads to hemolysis of the blood. This disintegration of the blood can be readily ascertained by examining the heart cavities, and then it is more

pronounced in the left than in the right ventricle. The cadaveric hemolysis, on the contrary, is more accentuated on the right side of the heart and within the field of the portal vein.

The spleen exhibits, as is generally true of cases of asphyxiation, a slight decrease in size, as indicated by a wrinkling of its capsule and a gray-red, somewhat anemic appearance of its pulp. On the sliced surfaces of this organ, the blood does not exude as richly as it does upon incision of the liver.

The submerged victim, attempting to breathe in his desperate struggle for life, swallows some water, and his stomach, in addition to its varying amounts of fluid already present, will then contain a considerable quantity of liquid. In adults, the ingested fluid may even trespass the pyloric barrier. The swallowed fluid may have, grossly and microscopically, the same characteristics as the medium in which the individual drowned. But this finding can not be used as a conclusive sign of death from drowning, since water may enter the stomach after death, similarly as it may the upper respiratory tubes.

Complete obstruction of the nose and mouth by fluid or water is sufficient to cause an individual to drown; a total submersion of the body is, naturally, not necessary. I have investigated cases of persons who in deep alcoholic intoxication fell face down, vomited, and asphyxiated by, or drowned in, their own vomitus. The lungs presented an extreme degree of ballooning; the aspirated food particles acted in a valve-like fashion, permitting entrance of air but hindering its exit.

While it is obvious that in a paper of this length not all the details of the lesions and conditions produced by drowning could be discussed, nevertheless the most fundamental and interesting lesions have been indicated and their significance exposed.

TOXICOLOGY IN THE MEDICOLEGAL NECROPSY

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Toxicology is the science of poisons. It deals with (1) the properties of poisons, (2) methods of detection and quantitative determination of the poisons in body tissues and fluids, (3) the lethal or fatal doses of various poisons, (4) the action of poisons on living tissue and (5) the proper antidotes to be used to counteract poisoning.

There is no substance known that acts in a harmful manner under all circumstances and in all doses. One cannot set a definite fatal dose for any one substance because it varies according to (1) the form in which it was taken (degree of solubility), (2) whether food was in the stomach at the time of ingestion (3) through what channels the poison was taken (gastro-intestinal tract, inhalation, absorption through the skin, by hypodermic, et cetera), (4) the quantity of poison actually absorbed into the internal organs, (that remaining in the gastro-intestinal tract has no bearing on the poisoning other than the degree of local irritation), (5) individual differences of tolerance and idiosyncrasies,* (6) age, sex, physical condition and habits of the individual and (7) rate of detoxication and elimination of the poison from the body.

One cannot distinguish between a medicine and a poison without knowing the amount taken (dosage). For example, $\frac{1}{30}$ grain of strychnine is a tonic, while $\frac{1}{3}$ grain is a violent poison to the average adult. Table salt, sugar, and even water, if given in great excess, may act as poison. Extremely small amounts of a substance may be entirely inert physiologically, but increasing amounts of the same material may be therapeutic, then toxic, and finally fatal.

* If a drug is given properly, in good faith and in accepted medical dosage any unfortunate results would not be considered as criminal poisoning.

DEFINITION OF POISON

A poison is a material of mineral, plant, or animal origin which, if introduced into the living body or brought into contact with any part thereof, in a soluble form and in sufficient quantity (with the exception of glass, needles, et cetera) will produce ill health or death.

The fatal dose cannot be definitely and accurately stated. It is the average amount of poison taken per kilogram of body weight that proves fatal. Due to individual differences, however, some animals may recover from this amount of poison while others may die from less than this amount. In man the lethal dose is taken as the smallest amount known to have proved fatal. This value for the lethal dose, however, is far from satisfactory for the following reasons:

(1) The history may be misleading or even erroneous; how much, if any, was lost by vomiting or excretion is not accurately known.

(2) The quantity absorbed and in the circulation and in the tissues is of importance only; that part of the material that is left in the gastro-intestinal tract after death has no bearing on the toxicity and death, with the exception of local corrosive action, if any.

(3) The condition of the individual, such as age, state of health, idiosyncrasies, et cetera, plays a part.

(4) The fatal dose differs when given in one or two large doses (acute poisoning) as compared with a small amount given over a prolonged period of time (chronic poisoning).

At present the "lethal dose" is still a hazy term and should not be given too much importance in the courts. In order to arrive at a better understanding of what constitutes a fatal dose in a case of poisoning, one must strive to get all the information possible regarding the previous condition and habits of the deceased, and must quantitatively analyze the various organs, tissues and body fluids (except the poison left in the gastro-intestinal tract). From the analyses, one must estimate as closely as possible how much of the poison had been actually absorbed into the body proper. It is the quantity absorbed and not the quantity taken

that is of importance. The smallest amount of poison actually absorbed into the body and positively known to have proved fatal to an average healthy person, should be known as the lethal absorbed dose.

LEADS AND CLUES

From a toxicological standpoint the first things that should command one's attention in a medicolegal necropsy are the leads and clues. Since analyzing for hundreds of poisons necessitates much autopsy material and is very time-consuming, a clue or lead toward some poison or group of poisons is very helpful. To get these leads there are two sources of information.

(1) The history and symptoms.

(a) *Vomiting, purging, abdominal pains* may indicate poisoning by arsenic, antimony, aconite, acids, alkalies, barium, cantharides, copper, digitalis, iodine, mercury, phosphorous, phenols, wood alcohol, veratrum, zinc.

(b) *Convulsions* may indicate brucine, camphor, cyanides, santonin, strychnine.

(c) *Coma* may indicate alcohol, atropine, carbon dioxide, carbon monoxide, chloral, chloroform, cyanides, ether, paraldehyde, phenols, opium group, sulphonal, veronal group.

(d) *Dilatation of pupils* may indicate belladonna, cocaine, gelsemium, hyoscyamine, nicotine, stramonium.

(e) *Contraction of pupils* may indicate muscarine, opium group, physostigmine, pilocarpine.

(f) *Paralysis* may indicate cyanide, carbon monoxide, carbon dioxide.

(g) *Slow respiration* may indicate carbon monoxide, opium group.

(h) *Rapid respiration* may indicate atropine, cocaine, carbon dioxide.

(i) *Delirium* may indicate atropine or cocaine.

(j) *Dyspnea* may indicate carbon monoxide, cyanide, strychnine.

(k) *Cyanosis* may indicate acetanilide, aniline, benzene, opium.

(l) *Pinkish discoloration* may indicate carbon monoxide or cyanide.

(2) Clues obtained at the autopsy.

(a) Corrosive action along the gastro-intestinal tract may indicate alkali cyanides, ammonia, caustic alkalies, fluorides, heavy metals, mineral acids, oxalic acid, phenols.

(b) Odor of body cavities: alcohol, benzene, chloroform, cyanide, ether, nitrobenzene, opium, phenol, et cetera.

(c) Luminous particles visible in the dark, phosphorous.

(d) White (grayish) particles, arsenic; other colors may indicate copper, picric acid, et cetera.

(e) Seeds, leaves, and other such material may indicate an active drug.

THE POSTMORTEM EXAMINATION

In all cases of poisoning, a complete autopsy is necessary, not only to determine whether lesions produced by poisons are present, but to rule out natural causes of death. Best results are obtained if the body is fresh and not embalmed since the formaldehyde from the embalming fluid interferes with tests for cyanide, carbon monoxide, phenols, and the color reactions for the alkaloids. Putrefaction interferes with the detection of alkaloids. The presence of certain characteristic pathological changes is not always conclusive evidence of poisoning, because most of these changes (except corrosive action) are produced by various organic diseases. The pathologist can only say that the changes noted are such as might occur from a certain poison. We must also realize that some of the characteristic lesions usually produced by a definite poison may be absent.

The toxicologist should be present at the autopsy for the following reasons:

(1) To get leads or clues from the history of the case and from the autopsy.

(2) To supervise the handling, taking, placing in clean glass containers and sealing of the autopsy material. The containers must be clean and preferably of glass; the material should not be placed in rusty tin cans or wrapped in towels and newspapers. This is to avoid contamination and the loss of the volatile poisons.

(3) To get the weight of the various organs; this is absolutely necessary for the quantitative calculations.

(4) To see that the stomach contents and the intestinal contents are carefully saved and that they are not brought into contact with the internal organs when the stomach and intestines are opened for examination. If examination of the stomach mucosa is not necessary, the stomach should be tied at both ends with the contents intact before removing the organ from the body.

(5) To see that some blood is properly removed from the heart chambers for carbon monoxide determination. In cases of suspected drowning, blood must be taken from the left and right heart chambers and placed into two clean dry bottles, sealed, and properly labelled.

(6) To see that sufficient quantities of the proper organs, tissues and fluids are taken at this time. This will avoid the added expense and extra work of exhuming the body in order to get the needed material. As a general rule, the stomach and contents, part of the intestines and contents, liver, brain, lungs, kidneys, heart, some muscle, blood, spleen, urine, some bone and some hair should be taken.

(7) If the body has been embalmed, it is absolutely necessary to secure a sample of the fluid in order to determine whether or not the poison found in the body was introduced by the embalming.

(8) To see that a sample of water, in a case of suspected drowning in a pool, is obtained for the purpose of analyzing it for chloride content, since the chemical test for drowning depends upon the chloride content of the right and left heart chambers and it is essential that we know how much, if any, chloride was in the water of the pool.

(9) To see that a sample of air or gas is obtained if the deceased was found in a man hole or if it is suspected that death was caused by fumigation or to the inhalation of carbon monoxide.

If the toxicologist is not present, the autopsy material should be put in clean containers, properly sealed and labelled with the name of the deceased, date of autopsy, names of witnesses present, careful record being taken. The material should then be

sent to the toxicologist by a responsible person and a receipt taken for it. A record should be kept of the date of delivery, the person who made the delivery and the person who received the material. All this must be done to establish a direct relationship of all materials for court identification.

NECROPSY MATERIAL BEST ADAPTED FOR ANALYSIS

In the incidence of persons who come to hospitals on account of poisoning, the first stomach washing must be saved for analysis (not the eighth or tenth washing). Large volumes or urine, if possible, and all the feces excreted should also be submitted. Some blood should be taken for gas analysis. If found dead, or if the individual lived only a few hours after taking the poison, the stomach and intestinal contents are of importance in order to determine the poison quickly (acute case). The poison is most easily detected in the stomach contents in acute deaths. With the stomach and intestinal contents, the following tissues are of greatest importance: the brain for testing for alcohol, alkaloids, benzol, chloroform, ether, veronal group, et cetera; the liver for fluorides, metals, oxalic acid, sulphonal, veronal group; the kidneys for metals, especially mercury; blood for gases, such as carbon monoxide, and for the test for drowning; bones, hair and nails for arsenic, lead, radium; the lungs for inhaled gases, to prove whether poison entered by inhalation; and the urine for arsenic, mercury, sulphonal, veronal group.

Substances like acids, alkalies, ammonia, nitrates, nitrites, chlorates, sulphides, et cetera can be identified in the stomach and intestinal contents only, because as soon as these substances enter the circulation they are oxidized, reduced or transformed into normal constituents of the body and, therefore, cannot be detected in the internal organs. Some of these substances produced changes in the blood pigment (hemoglobin) and, therefore, the blood should be examined spectroscopically.

If the patient lives several days (five or six), the poisonous gases, volatile poisons and alkaloids cannot be found; they have been destroyed or excreted. The veronal group can be found as long as ten to twelve days thereafter. The metals can be found

for several weeks thereafter, especially in the bones, nails and hair.

THE TOXICOLOGICAL EXAMINATION

(1) The laboratory. Privacy is a first requisite. The laboratory should always be locked when the analyst is absent. This precaution is necessary to avoid the possibility of someone maliciously introducing poison into the autopsy material.

(2) The reagents must be of tested purity.

(3) Planning the analysis. No haphazard procedure should be tolerated. The analysis must be carefully planned before starting in order to save as much material as possible, for one can never replace necropsy material once it is completely used up. At least one-third of the total amount of material must be kept intact and properly sealed for the use of some other analyst to check the findings, if the court so desires.

(4) Weighing the total organs and measuring the volume of fluids received is essential in order to have all data available that are needed for the quantitative calculations.

(5) Examining the stomach contents for nature of food and time of digestion, for undissolved poisons, seeds, leaves, reaction, odor, color, et cetera.

(6) The chemical isolation of the poisons. Almost every toxicologist has a pet system of his own. I use the following classification upon which the chemical methods used to isolate the poisons are based.

(a) Poisonous gases, such as carbon monoxide, hydrogen cyanide, hydrogen sulphide, oxides of nitrogen.

(b) Volatile poisons, such as alcohols, acetone, fusel oil, aniline, benzol, camphor, chloral, chloroform, carbon bisulphide, croton oil, cyanide, formaldehyde, nitro-benzene, phenols, phosphorous, pyridine, et cetera.

(c) Acid-ether soluble poisons, such as acetanilid, antipyrine, barbituric acid group, benzoic acid, caffeine, cantharadine, colchicin, di- and tri-hydric phenols, oxalic acid, phenacetin, picric acid, picrotoxin, salicylates, santonin, sulphonal group.

(d) Alkaline-ether soluble poisons, such as aconitine, atropine, amines (poisonous), cinchonine, cocaine, codeine, cytisine,

delphinium, emetine, heroin, hydrastine, lobeline, narcotine, nicotine, pelletierrine, pilocarpine, piperazine, quinine, strychnine, taxine, veratrine, yohimbin.

(e) Ammonia-chloroform soluble poisons, such as heroin, morphine, apomorphine, narceine, papaverine, theobromine.

(f) Metallic poisons, such as antimony, arsenic, barium, copper, chromium, lead, mercury, radium, thallium, uranium, zinc.

(g) Mineral acids and caustic alkalies.

(h) Halogens and their salts, including fluorides.

(i) Salts of oxy-acids, borates, chlorates, nitrates.

(j) Poisons isolated by special methods: Adrenalin, anthraquinone, curare, drastic cathartics, ergot, glucosides, hypnotics containing bromine, muscarine, saponins, nitroglycerine, strophanthin.

(7) After the isolation, the qualitative tests are applied in order to identify the poisons.

(8) Having identified the poisons, fresh material is taken and the amount of poison in every tissue is quantitatively determined.

(9) From the amounts of poisons found in the various organs, the amount in the entire body is estimated.

(10) Report of analysis and findings should be submitted in thesis form as soon as the work is completed.

(11) The isolated poisons or the positive tests obtained should be sealed in glass vials and kept for court purposes as corpus delicti.

TOXICOLOGICAL WORK

Toxicological work is most difficult and great responsibility is attached to it. Every chemist knows how phosphorus or strychnine is detected, but to isolate and detect 0.25 mg. ($\frac{1}{250}$ grain) of strychnine mixed with 500 grams of tissue is an entirely different matter. Much experience is necessary. The person to whom the chemical analysis is entrusted should be a chemist with years of experience in the analysis of necropsy material, he should be accurate, honest and trustworthy; his integrity must be of the highest degree and, indeed, above the remotest suspicion because his evidence may be the basis for the acquittal of the innocent or the conviction of the guilty.

The toxicological experience in the Chief Medical Examiner's Office in New York City is the largest in the world, not overlooking the medicolegal institutes of Germany, Austria and France. In this office there are analyzed annually over 2000 human bodies. Since its inception in 1918, the Chief Medical Examiner's Office in New York City has analyzed over 25,000 human bodies for poisons.

In the United States there are only two localities in which toxicological work of this kind is done as a routine, namely, New York City and Newark, New Jersey.

While writing this paper, I was called by long distance telephone about a case that was troubling the authorities. A man was driving along a country road in an open car. Witnesses saw the car swerve off the road and stop. The driver was found dead. The coroner, without any scientific investigation, signed out the case as one of carbon monoxide poisoning. Doctors who had treated the man for a few years claimed that they advised him not to take the trip because of heart trouble. Now they were trying to argue it out, whether the man died of carbon monoxide poisoning or of natural causes. It would have been better to analyze the blood of this man in order to determine the presence or absence of carbon monoxide. Most of the cases throughout the country are bungled in this way.

Sometimes a case receives much notoriety in the newspapers. Then the authorities seek the services of experts who demand exorbitant fees and usually are not experts in this line at all. This condition exists throughout the country at the present time and was also prevalent in New York City before 1918. The experts in the Rice case cost New York City $30,000 for trying to prove whether death was caused by chloroform or not. No analysis for chloroform was done. Instead, they argued it out in court. In the toxicological department of New York City a chloroform case of this kind would be completely solved in about two hours by chemical analysis. A rough estimate shows that the average cost to New York City for a complete toxicological examination, including grand jury and court testimony, is about $5.00 per cadaver. In New York City today every case of ac-

cident, suicide, homicide and most of the sudden deaths with no medical attendance have necropsies performed and chemical analyses made.

It may not be out of place to depict a few typical cases in which toxicology played an important rôle in solving a crime or the cause of an accident.

Case 1. *Analysis of the stomach contents, the main, or perhaps the only mark of identification of the deceased. The Becker Case.* Becker and his wife and two children lived in the Bronx, N. Y. Mrs. Becker suddenly disappeared. Letters mailed in Philadelphia to friends of Mrs. Becker stated that she was tired of living with Becker and, therefore, she had gone to Philadelphia; further, that she was well, and not to worry any more about her. Her friends, however, did not believe these letters. They knew that, although she might have gone away from her husband, she loved her children too well to leave them behind. They, therefore, brought the matter to the attention of the District Attorney.

Investigation was started by the police. Mrs. Becker could not be found anywhere. After a few weeks of good detective work, a clue was unearthed, that Mrs. Becker had been buried in the yard behind a garage owned by a friend of Becker. The police proceeded to search for the body in this yard. After quite some digging up of earth, they found the body of a woman completely covered with lye. The clothes, face, and most of the external part of the body were badly erroded by the lye so that it was impossible to identify the body. Autopsy revealed that the woman's skull had been fractured by a blunt instrument. No poisons were found present on chemical analysis. The stomach contents revealed grapes, figs and nuts.

Meanwhile the detectives sought the person who had last seen Mrs. Becker alive. They found it to be a woman, a friend of the Beckers. She stated that Becker and his wife visited her about ten o'clock on this particular evening. When asked what they had eaten at her home, she told them, without knowledge of the chemical findings, that she had given them grapes, figs and nuts. It was mainly upon the finding of these particles of grapes, figs and nuts in the stomach that the State succeeded in the identification of the body as that of Mrs. Becker.

The Beckers left the house of this woman about 11:30 p.m., got into Becker's automobile and started for home. On the way Becker feigned engine trouble and drove into the aforesaid yard. He got out and lifted the hood. He called his wife to come out of the car and see for herself. As she stooped down to look, he hit her over the head, knocking her unconscious. He then threw her into a previously dug hole, threw lye all over her and buried her. He was tried and convicted, and paid the penalty.

Case 2. *A camouflaged poisoning case.* An automobile was found burning in an out of the way road. A man also in flames was lying across the front mud guard, dead. A case of this description would have been signed out by coroners as one in which death was due to accidental burning. The Medical Examiner's Office, however, investigated. A necropsy was performed and a toxicological analysis made.

It was found by scientific methods of analysis that the man did not die of the fire or the fumes or smoke. He was dead when the fire reached him. Further analysis revealed large amounts of cyanide in all his organs. Death was due to cyanide poisoning.

The case was solved as follows: This man had suffered great financial losses. He was practically penniless. He had a family and wanted to provide for them. He took out a large insurance policy with double indemnity in case of accident. His intention was to commit suicide and at the same time conceal it from the authorities in order to get the double indemnity. He set the car on fire and, when it was burning well, he drank a solution of cyanide. He then threw the container into nearby shrubbery and fell dead over the front mud guard. Thus a case which had the appearance of accidental death by fire was proved to be one of suicide by cyanide.

Case 3. *One that appeared to be suicidal gas poisoning was proved to be murder by suffocation. The Freindlich Case.* Freindlich, his wife and three children aged 9, 7 and 2 years respectively, lived in an East Side tenement in New York City. On the morning in question the father left the home at about 7 a.m. About 7:30 a.m. one of the boys smelled the odor of gas. He ran into

his mother's room and found her in bed. He shook her but she did not respond. The boy called for help. The neighbors called the police who in turn notified the Medical Examiner's Office. On arrival, the Medical Examiner found that the room was filled with illuminating gas; the gas jet was open; the woman was dead in bed, lying on her back in a natural position. There was no pink coloration of the skin of her face or of any other part of her body (as is usual in carbon monoxide deaths). Lying in a crib a few yards away was the two year old baby, still alive. The baby was quickly removed to fresh air and saved. The absence of pink coloration of the skin of the woman and the fact that the baby was still alive and the mother dead, made the Medical Examiner suspicious and a necropsy was performed.

Toxicological analysis of the blood removed from the heart of the deceased mother showed complete absence of any carbon monoxide. This indicated that death was not due to inhalation of illuminating gas. The necropsy also showed that death was due to suffocation. Ten finger marks of compression were found on the back of her neck.

Freindlich murdered his wife for insurance money. He held her face down against the pillow until she was dead. He then turned her on her back, straightened out all the bed clothing, turned on the gas and left the house. He was tried and convicted. Coroners or inexperienced county physicians would have signed out the case as suicide by inhaling gas, whereas it was murder by suffocation.

Alcohol the cause of accidents

The toxicological laboratory of New York City quantitatively analyzes the brain for alcohol in all cases of fatal accident, the purpose being to determine whether alcoholic intoxication was a contributory cause to the accident.

Research work has been done in this laboratory on over 6000 human brains as well as on the spinal fluid and blood of living human alcoholics, and many series of experiments have been carried out on dogs in which brains, blood and spinal fluid were analyzed. From these experiments, it was determined that if the alcoholic

content of the brain or of the spinal fluid reaches above 0.25 per cent, it indicates that the individual was intoxicated. This was found to be true whether the individual was an abstainer or a habitue.

Case 4. *Case of a famous air pilot.* This flier was one of the first few who successfully crossed the Atlantic. Several years later he took off at Roosevelt Field with two male occupants. Within a very few minutes the plane crashed to earth and all three were killed. Examination of the wrecked plane revealed nothing as to the cause of the accident. A necropsy was performed on the deceased pilot and his organs chemically analyzed. The results of the analyses indicated that the pilot was intoxicated at the time he took off and evidently his condition of intoxication was the contributory cause of the fatal accident.

Case 5. *Planted body for purpose of collecting insurance.* This is the story of two undertakers who were partners in their business in a rural community. One of the undertakers took out a large life insurance policy with double indemnity for death due to accident and made his partner the beneficiary. Not many months later a bungalow that they owned was burned to the ground. The burnt body of a man was found in the ruins. The undertaker who was the beneficiary claimed that the body was that of his partner, and put in his claim for the insurance, asking for double indemnity because the death was caused by accidental burning. The insurance company started an investigation. A necropsy and a toxicological investigation were conducted. The results of the investigation revealed the following:

(1) The external part of the body was completely charred. The head was completely burned off. The feet and part of one leg were burned off. No identification was possible.

(2) By measurement of the bones of the extremities that were left, it was estimated that the deceased had been about two inches taller than the missing undertaker.

(3) Some parts of the internal organs were still in good shape, that is, they were not burned or boiled. Examination of the lungs showed a well developed pneumonia, whereas the undertaker in question was seen in apparently perfect health only two hours before the fire.

(4) Chemical analysis revealed no poisons, ruling out suicide by poison.

(5) Chemical work further revealed that the body found in the ruins had been dead when the fire started. The fire or fumes or smoke had nothing to do with this man's death.

(6) Toxicological analysis also revealed the presence of formaldehyde in the various organs. This strongly indicated that the body had been embalmed.

It was finally determined that the body was not that of the undertaker. It was a man two inches taller who had died of pneumonia and had been embalmed for burial. This body the undertakers planted in the house and then set it afire.

The five cases above outlined illustrate the kind of work the toxicological department of the Medical Examiner's Office in New York City is doing.

In conclusion, it will not be out of place to call attention to the National Research Council's Bulletin Number 64 (Washington, D. C., p. 75, 1928), where the following statement is made concerning the work of the Chief Medical Examiner's Office of New York City:

> In the scientific attainment and administrative ability of its chief, in the character and volume of the work done, in the working facilities and budget allowed it, in its functioning in the investigation of crime, in its cooperative relation to other agencies, in the service which it gives to the public, and in its freedom from political interference, the office of the Chief Medical Examiner of New York City is the most outstanding agency devoted to forensic medicine in the United States.

DISCUSSION

Wm. D. McNally, Chicago, Illinois: Toxicology is a broad subject, it treats of poisons, their origin, properties, physiological action, treatment of their noxious effects and their detection by chemical or other means. The toxicologist is a scientific detective looking for clues as to the rôle played by poisons in causing death.

Dr. Gettler spoke of the use of embalming fluids interfering with the detection of poisons. Where a body has been embalmed, a portion of the fluid used should be examined by the chemist for

the presence of poisons. The lack of this precaution, placed a pathologist and chemist in a near by state in a most embarrassing position.

A man was found early one morning in a small car, which was wrecked against an abutment on the highway. He was taken to a hospital. Late that afternoon he said he felt well enough to go home and was released by the hospital. The following morning he died at his home. An autopsy was held by the local coroner, who gave as the cause for death: "ruptured stomach." The undertaker prepared the body for burial. Late in the afternoon an insurance company wanted a second postmortem which was granted. The liver, kidneys and stomach were removed for chemical and pathological examination. The insurance company a short time later received a report that "death was due to arsenical poisoning."

The man was a crank on life insurance and had taken out over $140,000. Every policy was contested. The family employed counsel. He came to Chicago and wanted assistance. The family knew the deceased did not commit suicide. Drug stores in neighboring towns were canvassed, no purchase of arsenic could be found. I requested specimens of the embalming fluids and hardening compounds used after both postmortems. The samples were received, analyzed and a short telegram dispatched, "Mystery solved, letter to follow." A few weeks lapsed and a lawsuit was started. The insurance company introduced the pathologist who testified that he found grossly and microscopically, evidence of arsenical poisoning. The chemist reported 15.4 grains of absorbed arsenic in the stomach, arsenic in the liver and kidney. The plaintiff introduced the undertaker who had embalmed the bodies and submitted samples to me for examination. Bottles of embalming fluid and a large jar of hardening compound contained over 50 per cent of arsenic trioxide. This compound had been used after the first autopsy, the organs covered with this arsenic compound had been removed and reported as the causal agent for death.

Of course the widow received all of her insurance.

We hear frequently that aviators are half intoxicated when

entering their ship. Dr. Gettler's analysis of the organs of an aviator killed while driving his plane appears to bear that out. In one fatal case in Chicago, I found carbon monoxide in the blood of the pilot.

In Chicago, in 1913 I established under Coroner Peter Hoffman the first Coroner's laboratory in the United States which was several years ahead of the establishment of the laboratory of the Medical Examiners in New York.

In Cook County we can not equal the price of $3.00 per toxicological examination as given by Dr. Gettler. The salary of the chemists and the overhead expenses would bring the cost above $3.00 per case.

I dislike very much the reporting of alcohol by the plus sign, one plus, two plus or four plus. As each one of these indicates a certain percentage of alcohol, I believe that the percentage should be used.

Dr. Gettler spoke of clean glassware being used for submitting specimens and I would like to add that metallic tops to jars should never be used, as arsenic and lead are frequently found in the metallic tops giving an opportunity for defense attorneys to claim contamination of the organs examined.

Manufacturers of chemicals and drugs are always a jump ahead of the toxicologist and it is necessary to develop methods of detection for each new group of drugs produced. Some poisons escape detection because of lack of delicate methods or because of chemical changes that these drugs undergo in the body or after embalming.

MEDICAL EXAMINERS' FINDINGS IN DEATHS FROM SHOOTING, STABBING, CUTTING AND ASPHYXIA

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Part I. Death from Shooting

HOMICIDAL SHOOTINGS

Shooting has always been a common method of committing murder. It apparently reached its highest peak of popularity in the United States and incidentally in the world, during the last few years of our recent prohibition era, when it became the chief method of killing amongst gangsters, racketeers, hi-jackers, hold-up men, et cetera.

During an eight year period (1925–1932) in Essex County out of 360 homicides, 167 were killed by shooting, constituting 46 percent of the total number.

In 2,457 homicides in New York City during a five year period (1928–1932) 1,386 lost their lives by shooting or 56 percent of the total murders.

Homicides by shooting, therefore, form at least 50 percent and over of the total murders occurring in and around the metropolitan district of New York. The methods of killing next in frequency are stabbing and cutting, assault and battery, and strangulation by ligature.

In main, the popularity of shooting lies in the fact that close contact with the victim is unnecessary, the danger of a fight is avoided and the automobile usually affords a quick getaway.

SUICIDAL SHOOTINGS

Shooting is also a common way of committing suicide.

In 1,056 suicides in Essex County during an eight year period

(1925–1932) there were 172 suicides by shooting or 16 percent of the total suicides.

In 7,219 suicides in New York City during a similar five year period (1928–1932), 694 or 10 percent of the total suicides were due to shooting.

Suicides by shooting, therefore, form only about 10 percent of the total suicides occurring in and around the New York district. The commonest methods are the inhalation of illuminant gas, hanging, jumping from buildings, shooting, poisoning, stabbing and drowning, in order of frequency.

ACCIDENTAL SHOOTINGS

In large cities accidental shootings are not common. They occur especially among boys playing with firearms.

WAR WOUNDS

The familiar GSW's of the World War forming the major part of the battle casualties, produced by fragments of high explosive shells, by machine gun and rifle bullets, hand grenades, et cetera, will not be considered here.

TYPE OF WEAPONS USED IN CIVIL WOUNDS

In suicidal shootings the commonest weapon is the *revolver.* This is usually a cheap model, in poor or neglected condition, of .32 or .38 caliber, discharging a lead bullet of low velocity. Often, however, a good revolver or an automatic pistol of .25, .32, .38, or even .45 caliber is used. Occasionally, a shotgun or a rifle is the weapon of choice.

In the ordinary gin mill and lust murders cheap revolvers are usually employed. Amongst gangsters better revolvers, automatic pistols and often high velocity weapons such as machine guns are used.

In accidental shootings the weapon is often an automatic pistol, —a dangerous weapon in untrained hands since the barrel often contains an unsuspected cartridge. Among hunters accidental shooting with shotguns and rifles are all too common.

VIEWING BODY AT SCENE OF DEATH

In all shooting cases when a dead body is found, it is of prime importance that the scene be visited by the medical examiner and that nothing on the body, or in its immediate vicinity, be touched until his arrival.

In New York City and Essex County, the medical examiner under the law "must go to the dead body and take charge of the same." In all homicide and suicide cases, the viewing of the body at the scene of death by an experienced medical officer is of vital importance. The medical examiners in these areas, upon arrival at the scene have precedence over all other individuals and agencies, and until his medical investigation is completed and he has selected and taken possession of such objects as he decided may aid him in his investigations, no one, not even the police, may take charge of or remove the body or any object whatsoever.

Effective coöperation with the police is absolutely essential, and under the medical examiner's system the police and medical examiners work as one unit toward a common cause—the detection of crime and the fixing of criminal negligence.

In suspected murder cases the homicide squad often arrives at the scene before the medical examiner they are, however, trained to touch nothing until his arrival. Then all work together, the photographer, finger print man, et cetera. A careful inspection of the body and its surroundings is made noting everything that might assist in determining whether the shooting was accidental, suicidal or homicidal. In the event of murder everything, which may lead to the detection of the murderer, is noted.

Proper instruction of the police and ambulance surgeons soon prevents the careless picking up of a weapon if found, or other important clues.

If there is any doubt as to whether the victim is dead, any necessary disturbance of the clothing or moving of the body for the purpose of determining this by ambulance surgeons or physicians called in in the emergency is, of course, excusable.

Notes should be taken, on the spot, by the medical examiner to his stenographer, or in long hand when a stenographer is not avail-

able as to the position of the body, its temperature, the absence or presence of rigor mortis, how the body is dressed, and the location of the wounds. The body should not be moved too much for this purpose until photographs have been taken.

Absence of the weapon, usually means murder, but a careful search must be made, since suicides, after wounds which would apparently indicate sudden death, may throw the gun out of the window or in a dark corner.

Furthermore, the presence of the gun in or near the hands of the dead man, though usually indicating suicide, may have been placed in the hand of the dying man by the murderer.

Search should be made for powder marks or burns on the hands of the deceased, since often in suicide by means of cheap revolvers, a flare back may occur from the chamber of the gun. Powder marks or burns on the hands do not always indicate suicide since they may have been produced in a struggle with the murderer.

In the examination of the wounds it is sufficient only that their main characteristics be described, and an attempt be made to determine chiefly whether they are wounds of entrance or exit, since their closer examination will take place at the morgue under better light and circumstances.

Careful search should be made for empty shells, ejected from either automatic pistols or repeating rifles; they are usually found in the immediate vicinity of the weapon or near where it was fired.

Spent bullets may often be found on the floor or under the body, and search should be made for embedded bullets in plaster, woodwork, furniture, pillows, and other objects, when necessary.

The gun if found should be carefully picked up, preferably with a clean handkerchief, so as not to disturb finger prints, and unloaded. During the unloading the muzzle should never be pointed towards anyone and the medical examiner should acquaint himself with the proper method of breaking and unloading the various types of firearms, especially the automatic pistol.

Except in cases of clean cut suicide, the body should be photographed as well as the surrounding rooms or location. After the police photographer has finished with the body it may either be reëxamined more closely at once or later at the morgue.

Personal effects and identification cards, letters, et cetera, are usually removed at this time by a thorough search of the clothing as this usually gives police early clues to work on.

The body is then sent to the official morgue at which place it must not be disturbed or undressed until the arrival of the medical examiner.

THE NECROPSY IN SHOOTING CASES

Undressing the body

The body should be undressed by the medical examiner with the assistance of the morgue keeper, or by the morgue keeper under supervision. Care must be taken to watch for bullets that might drop from the clothes; they are frequently found between the skin and clothing, lacking the force to come out through the clothes. The same precautions should be taken in undressing wounded men in the receiving rooms of the hospitals.

It is a good plan to start with the shoes and work up, describing the condition of the various articles of clothing to the stenographer, as they are removed. Holes made by bullets entering and leaving the clothes should be carefully described, especially the holes of entrance in the outermost garments where clinging powder grains and burns may readily be seen. If found, the clothing should be carefully folded so that this evidence will not be lost. Clothing in all murder cases should be saved and properly marked for the crime detection bureau of the police or for the district attorney.

IDENTIFICATION OF BODY

Proper identification of the body must be made in all important cases before the necropsy begins. If the medical examiner has seen the deceased at the scene of the shooting he can identify the body he is about to autopsy as the one he examined at place of death.

If the medical examiner has not previously seen the body, especially in cases dying in hospitals, an identification must be made in his presence by the police officer who brought the victim

to the hospital, or by relatives or friends of the deceased. This should be taken down by the stenographer as a part of the necropsy protocol, giving in detail the names and addresses of those who identify body.

The Necropsy

After the body has been undressed and properly identified, the necropsy should be conducted in a careful routine manner. All wounds of entrance and exit should be carefully examined and described. In examining wounds of entrance care should be taken not to wash off powder smudge or partly embedded powder grains when cleansing the wound of blood. The wounds should then be photographed. It is good practice to measure in inches* the distance above the heel of every wound of entrance and exit. The height of the wound of entrance and exit above the heel will often make it possible to reconstruct the direction of the shot and to tell on what line the gun was when fired.

Before starting the internal examination of the body it should be turned and the back examined. Bullets of .32 or .25 caliber do not usually possess sufficient velocity to pass through the body and can often be felt underneath the skin of the back. They are frequently surrounded by a small hematoma.

The necropsy is then performed in the routine manner. For years we have used the ordinary Virchow technic in performing both scientific and medicolegal autopsies, and seldom find it necessary to remove the organs of the chest and abdomen "en masse." We believe that many points of importance may be missed in removing organs in toto, as the amount and character of the blood in right and left heart cavities; the presence of fat emboli; the condition and contents of the bronchi; the presence of pulmonary embolus and its dislodgement, et cetera. We prefer removing one organ at a time, describing lesions as encoun-

* In medicolegal work we prefer the use of inches, having entirely given up the metric system as applied to measurements. Centimeters mean nothing to an American jury and probably never will. The weights of organs can still be taken in metric system as they are not often needed in court and can easily be transcribed.

tered. The course of a bullet through the body is seldom lost since it is always marked by a path of hemorrhage.

The wound of entrance and exit in all the organs are described in the individual examination of each organ and the direction and course of a bullet is finally summed up after it has been traced from entrance to exit, or to the location where it was found.

If a bullet is found loose in the pleural, peritoneal or pelvic cavities, or in the subdural space, the location where it was found cannot be taken as a fixed point since it may have shifted to this position by gravity. The finding of a bullet over the left occipital lobe may result from the reclining position of the body after death, and the real point of exit in the brain may be over the left frontal lobe where the point of impact may often be noted on the interior of the calvarium by the presence of a bursting fracture.

When, however, a point of exit is found in the spine or in the posterior thorax, provided the bullet has not been deflected by striking bone previously, this point of exit when joined by a large probe with the point of entrance, gives a good idea of the general direction of the bullet, and it is good practice to measure how far the fixed point of exit is behind, below, or to the right or left of the fixed point of entrance.

Furthermore, the actual hole of entrance in the skin is often not a fixed point for measuring, for instance, when it is found in the arm or in the region of the female breast. The skin wound may not correspond to the wound of entrance in the chest wall in the prone position of the body at necropsy unless the parts are placed in the same position as they were when the shot was fired.

Great difficulty may arise when two, three or more shots enter the body in near proximity or their tracts cross each other in the body. The course of different bullets often crisscross each other and considerable experience is needed to properly interpret the correct course of each individual bullet.

When a bullet after passing through thoracic or abdominal organs, finally leaves the body cavities and becomes embedded in the back, spine or pelvis, the tract may often be lost, since there may be very little hemorrhage in a bullet tract through bone. Much time is often saved by fixing the point at which the bullet

has left the internal cavities of the body, by turning the body over in a position to cut down on the overlying muscles, and other structures. Hemorrhage will quickly be found, if the bullet has passed through to the back, by using large clean cuts and following them up to the location of the missile. Where there is no hemorrhage there is no bullet.

There is no place in the body where a bullet may not lodge and sometimes it becomes necessary to search for hours unless x-ray facilities are at hand. Sometimes the bullet may be deeply embedded in the body of a vertebra, and may be entirely missed by lying $\frac{1}{4}$ of an inch beyond a saw cut. In such cases a great deal of time will be saved by examining the body or certain portions of it by means of the x-ray.

It is surprising that practically no necropsy rooms in this country are provided with x-ray equipment. We have x-ray facilities, but it is often inconvenient to transfer a dead body partly examined to an x-ray department and ask for certain examinations. It would be of great value to the medical examiner in locating bullets, and certainly to the hospital pathologists in the study of bone diseases and skeletal metastases to have x-ray equipment in or adjacent to the necropsy rooms. It would be particularly useful in this country where the examination of the skeleton at necropsy is, for obvious reasons, a very limited one.

Occasionally bullets cannot be found in cases in which there is no apparent exit from the body. Some of these cases have spat up or coughed up the bullet; others may have been swallowed and lost in the stool, or, rarely, found in the intestinal tract.

The necropsy should be completed with great care and a verbatim dictation typed into a protocol. This should be signed by the medical examiner who performed the necropsy. It should be filed as an official record in the office of the chief medical examiner. Special anatomical charts of the surface and different parts of the body are useful for charting the location of the wounds. Microscopical, chemical or any other examinations that are necessary should be completed, or the specimens taken before the body is released for burial.

Marking bullets for identification preservation

All bullets must be properly marked and kept safely for future identification, study or for trial. It is very difficult to properly mark bullets, since practically only the butt is available. The riflings on the sides must be left intact for the ballistic expert. If the butt is flat, an identification mark, a number or initials may be marked by the use of a small jeweler's die or tool. The difficulty is that there is room only for a small symbol, and when handling a large number of bullets, this means very little in the way of identification.

If the butt is deeply conical it is practically impossible to mark a small bullet. I have had my identification mark on such a bullet covered with wax used by the ballistic expert in fastening the bullet to the comparison microscope. Later at the trial I was chagrined at being unable to find any mark until the wax was removed.

For these reasons we do not mark bullets except in unusual circumstances. We prefer keeping them in sealed envelopes containing a description of the bullet with other important data in the handwriting of the medical examiner. If the bullet is needed by the prosecutor it can be obtained on receipt by a responsible officer, who later returns it to the medical examiner. At the trial the bullet is introduced by the medical examiner when testifying as to the cause of death. This prevents much wrangling.

REVOLVER WOUNDS

Revolvers usually shoot lead bullets of low velocity, 640 feet per second being about the maximum speed. The cartridges which formerly contained black powder are now frequently loaded with smokeless powder. This is of prime importance since the blackening and tatooing described in most textbooks is either insignificant or not present at all in many revolver wounds seen at the present time, due to the almost complete combustion of smokeless powder. Smokeless powder burns more rapidly, produces greater velocity and does not smoke or foul the barrel.

It is also possible to load revolvers with jacketed ammunition designed for automatics. This, however, is not common. Prac-

tically all revolver and pistol ammunition is now center fire. The old rim fire is seldom seen except in small pistols and rifles used in shooting galleries.

The calibers more commonly used in revolvers are .22, .25, .32, .38 and .45. These calibers are used in automatic pistols and rifles also. The caliber of a cartridge or gun is designated in hundredths of an inch. For instance, when we speak of a "Colt .38" we mean a Colt revolver of .38 caliber which takes a cartridge having a diameter of 38/100ths of an inch.

Continental firearms are, of course, calibrated according to the metric system.

While the cartridges for a .38 caliber Colt are made for this gun by the manufacturers, they can be used in any other revolver of the same caliber. They can also be used in automatic pistols, repeating rifles and machine guns of the same caliber. Thus, from the size of a bullet and shell alone, one cannot tell whether a revolver or rifle was used.

Contact revolver wounds

When the muzzle of a .32 or .38 caliber revolver is held against the skin and fired, the wound of entrance is usually larger than the diameter of the bullet. Frequently it is a lacerated, stellate or cruciform wound which does not resemble a bullet wound in any way.

This is due to the fact that the gases from the explosion enter the wound and cause subcutaneous excavation, often tearing the skin wound, the subcutaneous tissues, and producing a large blackened hole or laceration. There may be slight burning (brand) about the wound, but since the gun cannot kick there is no particular location of the brand. Blackening due to a powder smudge which can be wiped off, may show around the edges of the wound and may result in slight tatooing (embedding of unexploded or partly combusted powder grains) in the skin about the wound.

However, if the gun is tightly pressed against the skin, as it often is in suicide and gangster murders in administering the coup de grâce, there may be no marks in the surrounding skin,

and the wound of entrance may be seen as a large, torn, black hole with a charred bed.

If the body is protected by clothing over the wound of entrance, the clothing often shows a cruciform tear with firing of the clothes. This firing may produce quite an area of burning in the underlying skin.

If the bullet passes through the body without striking bone or without too much loss in velocity, the wound of exit is often a round hole about the diameter of the bullet with everted edges, the wound of entrance being larger in these cases than the wound of exit.

Near contact revolver wounds up to six inches from body

If the revolver is fired near the skin the wound of entrance may resemble a contact wound. If fired at a distance of one to 6 inches from the body, the shape of the wound is usually round or oval and approaches the diameter of the bullet, depending on the angle at which it strikes the skin. In such cases a brand or area of burning caused by the escape of explosive gases from the muzzle of the gun may be seen about the wound. This brand is often concentrated in an oval area most marked over one side of the wound. This is caused by the upward kick of the gun when fired and is good evidence that the trigger of the gun was in a position opposite this mark. Scorched or burned hair may be found in this area.

A sharply demarcated area of blackening or smudge may be noted around the wound, often covering an area about one inch in diameter. It is caused by a powder smudge and can be wiped off.

Tatooing caused by the embedding of incompletely burned powder grains in the skin may be seen around the wound. This may be extensive when black powder is used. Ten to 100 or more grains may often be counted. The tatooing may extend quite a distance from the wound. For instance, in a bullet wound of the cheek, powder burns may be noted over the concha of the ear and may denote the direction of the shooting. Flakes of powder resting on or slightly embedded in the skin are easily dislodged

and care should be taken in cleansing the skin, or in folding the clothes, not to destroy this evidence for further examination.

With smokeless powder, very little blackening or tatooing may be present and a hand lens is often useful in the examination of such wounds.

Revolver wounds made at a distance of six to twelve inches from body

When the muzzle of a .32 or .38 caliber revolver is held at a distance of from six to twelve inches from the body and fired, the bullet wound of entrance is usually about the size of the bullet. There is no tearing or laceration of the skin. The bullet hole is usually round with its margins bruised and its edges inverted when the angle of fire approximates a right angle to the surface of the body. If the bullet strikes the body at an angle, the wound may show a tangential bruising to one side, the so-called slap shot. At this distance the brand or burning is usually absent, or if present, slight in extent. The wound still shows a small amount of blackening or powder smudge as a rule, especially if black powder is used. Tatooing may still be present but is usually small in amount. There is no firing of the clothes at this distance.

Revolver wounds made at a distance of two to three feet and over

At these distances the wound of entrance is a round hole about the size of the diameter of the bullet. The edges are often slightly inverted and may be slightly discolored from the lead or grease of the bullet. There is usually a thin contusion collar about the wound, the skin being abrased or bruised by the lateral walls of the bullet as it penetrates the skin.

If the bullet strikes a body at an angle, the wound of entrance is a round or slightly oval hole often with a tangential bruising or abrasion on the skin, denoting that the bullet has entered at an oblique angle, an important point in estimating the direction of fire.

The brand or burning, the blackening or smudging and the tatooing at these distances have entirely disappeared. The clothes simply show a round or lacerated tear of entrance and are free from burning or powder.

Can the caliber of the bullet be estimated from the size of the wound of entrance?

Except in contact shots or near contact shots in which the wound of entrance is often larger than the bullet, all shots at greater distances produce, as a rule, a round hole of entrance which approximates the size of the bullet. Due to the elasticity of the skin, however, an accurate estimate of the caliber of the bullet cannot be made. Roughly we may state that wounds made by .38 and .45 caliber revolvers are usually one-fourth of an inch or more in diameter, and those made by .32 and .25 caliber guns are a little smaller than one-fourth of an inch. If the victim lives a few days the dried scab and retraction so distorts the wound that no estimates can be made.

Wounds of exit

Except in contact shots or near contact shots in which the wound of entrance is often larger than the wound of exit, when a revolver bullet passes through the body, losing little in velocity and failing to strike bone, the wound of exit may closely simulate the wound of entrance in size. Usually the exit wound is a trifle larger, its edges slightly everted, and sometimes a strand of tissue may be seen hanging from the wound. Sometimes it may be quite difficult to determine a wound of exit from one of entrance, especially if the person has lived a few days. Of course, there would be no evidence of burning, smudging or tatooing about the wound of exit.

Often one must resort to a careful examination of the clothing to distinguish between wounds of entrance and exit, the examination often settling the question. Burning and firing of the clothes without the underlying skin being affected may show the wound to be one of entrance. Strands of clothing may project externally around a hole in a coat signifying an exit.

Revolver bullets of .38 and .45 caliber often pass through the body, while those of .32 or smaller caliber are slowed up and their velocity so reduced that they frequently remain in the body. They are often found beneath the skin of the back.

Bullets which pass through the body with loss of velocity on

account of the greater distance fired, or from the resistance of penetrated tissues, or because they were fired from poor guns, usually produce wounds of exit which are much larger than the wounds of entrance. They are easily diagnosed and often show extensive tearing with everted edges.

The bullet usually remains in the body if bone is struck. If it leaves the body it often produces a large hole of exit due to loss in velocity, splitting or mushrooming the bullet, or to some spicules of bone blown out with the bullet. Sometimes more than one hole of exit is thus produced.

In passing through the skull a bullet often makes a wound of entrance consisting of a sharply cut round hole beveled on the inner table, while the wound of exit is much larger and is beveled externally. This is characteristic and may sometimes, in an exhumed body when the wounds in the soft parts have been obliterated by decomposition, settle a question of murder or suicide.

Deflection of bullets

Ordinarily bullets are not deflected from their course in passing through the body unless they strike bone. Therefore, if a large probe can be passed through the wound of entrance and out the wound of exit, it usually denotes the direction of the bullet through the body. A continuation of this line from the wound of entrance shows the line at which the barrel of the revolver was when the shot was fired. This is all one is safe in testifying, unless one has witnessed the murder and knows the actual position of the body at the time.

AUTOMATIC PISTOL WOUNDS

Automatic pistols fire a jacketed bullet of high velocity attaining a speed of from 800 to 1,200 feet per second. These bullets are often spoken of as "steel jacketed." This is erroneous since a steel jacket would ruin the rifling of a gun. The jacket is usually of copper or cupronickel, some of the recent ammunition being covered by a plating process. The cartridges contain smokeless powder.

Wounds produced by automatics do not possess all the characteristics of revolver wounds and are much more difficult to interpret. Absence of burning and discoloration in close discharges are common, and the wound of entrance must often be examined with a hand lens, and even chemical examination of the edges may be important. There is much greater penetration with such weapons. Otherwise both wounds of entrance and exit are the same as for revolvers.

MACHINE GUN AND RIFLE WOUNDS

Accidental shooting by means of a small .22 caliber rifle occasionally occurs in boys playing, or taking "pot shots" at electric lights or windows. In rare instances such a weapon may be used for committing murder. Such wounds do not produce much damage unless they penetrate some vital organ producing internal hemorrhage, peritonitis or infection. While apparently insignificant they are often tricky and produce unexpected damage which is fatal.

Larger rifles are occasionally used in committing murder and suicide. Accidental shooting with high powered rifles in some parts of the country is common, especially in the hunting season.

Gangsters frequently use machine or submachine guns in "bumping off" their victims.

Practically all of these weapons shoot bullets of high velocity, often attaining a speed of from 2,000 to 3,000 feet per second.

At short range up to 200 yards, the rifling of the gun barrel rotates the bullet about 2,500 revolutions per second and causes an eccentric whirling of the butt. This produces extensive bruising of the deep tissues and tremendous fragmentation of bone.

With high velocity rifles, the wound of entrance is often smaller than the diameter of the bullet. The edges are depressed with a reddish zone around the circumference which becomes brown on drying. If the bullet strikes at an angle, the skin may be split or extensively ploughed up.

At medium range, 300 to 1,000 yards, the tissues are cleanly cut and a clean hole is made in the bone. The eccentric whirling of the butt largely disappears.

At long ranges, 1,000 yards or over, the bullet loses so much velocity that extensive wounds of exit may result.

SHOTGUN WOUNDS

All shotguns are now more or less choke-bored, that is the barrel at the muzzle is smaller in diameter than at any place behind the muzzle except the chamber. Barrels, therefore, may be full choke, half choke, one-quarter choke, and of the old cylindrical bore. The rate of dispersion of the shot depends on the amount of choking in the barrel.

Cartridges used in shotguns are first loaded with powder, on top of which is placed a cardboard and two or three felt wads. The shot is then placed on these wads and held down by a single cardboard wad, over which the edge of the cartridge shell is crimped.

The shot used is either soft lead or chilled and is designated according to size, as buckshot, and numbers, 2, 4, 5, 6, 7, 8 and 9, the lower the number, the larger the size of the pellet.

Shotgun wounds made at close range

When an ordinary shotgun is fired a few inches from the body, the entire charge, often including the wads, enters the body "en masse" producing a large ragged hole with extensive tearing of the underlying tissues and rupture of the underlying viscera. The hole is blackened, burned and tatooed, often with powder driven deep into the wound. Frequently in a shotgun wound of the chest, wadding and bits of clothing may be found lying against the spine, together with firing of the clothes.

At the distance of one yard the shot still enter the body as one mass, but the hole is more regular in outline, usually round and about one inch in diameter. Firing of the clothes is common.

Shotgun wounds made at 2 to 4 yards distance

At a distance of two to three yards the wound of entrance is still a ragged hole with most of the shot entering the body en masse. However, there is a beginning scattering of individual shot, some striking and entering the body usually above the top

of a large wound, due to the upward recoil of the gun. There is no burning or blackening at these distances but a certain amount of tatooing may still be seen.

At the distance of four yards, dispersion has reached such a degree that the shot enter the body as individual pellets covering a square pattern about six to eight inches in diameter. Many of the shot enter the body in small groups.

Shotgun wounds made at ten yards distance

At ten yards the shot enter as individual shot without any grouping and cover a square pattern about twenty inches in diameter.

Shotgun wounds in general

Naturally the above examples are to be used only as a general guide in the approximate determination of the distance the shotgun was fired. Each individual case, especially if it turns out to be an important one in which the life of an innocent man may be at stake, should take into consideration the exact gauge of the gun in question, the amount of choking of the barrel, the type of ammunition used, et cetera. Test shots and a complete study of the situation by a ballistic expert may be necessary.

The dispersion with fully choked barrels is about one half of that given in the above examples. With smokeless powder there is much less blackening and tatooing, the powder stains usually being greyish in color.

In general, shotgun wounds may be homicidal, suicidal, or accidental. Sometimes a wound apparently insignificant because of its size and location may produce death from internal hemorrhage. In suicidal shootings the trigger may be pulled in a variety of ways, some of which are often ingenious. For instance, the gun may be fired with the foot by using a bent piece of wire laid over the triger and by many other devises.

SUMMARY

The most important question, of course, for the medical examiner and police to determine is whether the shooting was murder, suicide or accidental.

Herzog (sec. 282, p. 234) states

> The question whether death was due to murder or suicide arises frequently and often even the closest and most careful examination will fail to determine it, as persons in committing suicide frequently cut and wound themselves in such revolting and barbarous ways that the corpse and its surroundings present the appearance of murder should no more bias the examiner toward that conclusion than that a case presenting all appearance of suicide would cause the examiner to conclude that he has to deal with a case of suicide; for even as a suicide may in his suicidal rage unwittingly, or perhaps because his insurance policy has not yet run long enough to make it incontestable in case of suicide, give his death the appearance of accident or murder in order to entitle his beneficiary to the insurance money, even so a murderer may and will often, to avoid suspicion, do everything possible to make the murder committed by him appear a case of suicide or accident.

Persons committing suicide by shooting or by cutting their throats, frequently stand in front of a mirror.

The location of the wound often affords considerable evidence as to whether the wound was homicidal, suicidal or accidental.

Suicidal wounds are usually situated in the front of the body or in those parts most easily accessible. In right handed persons the bullet wound of entrance in the head is usually in the region of the right temple or in front of the ear; in left handed persons the wound is on the left side. Occasionally the wound may be found in the roof of the mouth.

Homicidal wounds may occur in any part of the head but are most commonly found on the back of the head, the shot usually being fired from the rear. In victims taken for a ride the coup de grâce is often found in the back of the head near the external occipital protuberance, the shot being fired by the gangster sitting in the back seat of the automobile and the gun placed against the base of the skull.

Some parts of the body cannot be reached at all or only with difficulty by a suicide, thus wounds in the back are usually homicidal.

Although the person who has decided on self-destruction usually adopts the methods which are obvious and which he believes will result promptly in death, there are many cases reported in which very unusual means are employed, so that one must not be misled by the type or situation of the wound.

Taylor[9] states

There is no wound which a suicide is capable of inflicting on himself which may not be produced by a murderer; but there are many wounds inflicted by a murderer which, from their situation and other circumstances a suicide would be incapable of producing on his own person.

Was death instantaneous?

Herzog (sec. 294, p. 242) states

In many instances the amount of blood surrounding body will show whether the person bled to death; the appearance of the wound will show whether death was instantaneous or almost so. Thus for example, where a person places the barrel of a gun into his mouth and pulls the trigger, blowing off half of his head, there can be no doubt that death was instantaneous, but a tiny hole in the center of the forehead, caused by a .22 caliber rifle bullet does not negate the possibility that the dead person may have done some voluntary act after receiving the wound.

Contrary to lay and some medical opinion, a bullet wound of the heart does not always produce immediate death. After such a wound it may be possible for the victim to walk a considerable distance, or to perform certain acts, since the bleeding into the pericardium leaks out of the wounds in the parietal pericardium into the pleural cavity and prevents tamponage of the heart.

Was the wound made before or after death?

Herzog (sec. 295, p. 243) states

A physician may be asked whether from the appearance of the wound itself he can tell whether it has been produced during life or after death. This is hardly possible with absolute certainty if the shot has been fired very shortly after death. Whether a bullet is fired into a living body or into a dead body, the mechanical effects of the projectile will be the same. A physician may often tell from surrounding circumstances, the spattering or squirting of arterial blood on the walls or from the position in which the body was found, that the bullet was fired into a living person. In case it was fired into a dead person a few seconds after death, there will still be some bleeding but there will be no arterial squirting. This, however, may often not be noticeable even if it has occurred, as the clothing, through which the bullet has passed may absorb the blood.

Furthermore, the necropsy will usually reveal whether the bullet has been the cause of the death, not only by determining

which vital organ has been perforated and the damage done, but also by excluding any other cause of death.

It has been the opinion of most authorities, therefore, that the main distinguishing point in wounds inflicted before and after death is the presence or absence of bleeding. It is true that cuts in the skin, when made after death, usually show no bleeding and contain no clots. Some bullet and stabwounds, however, when made soon after death, will bleed if they penetrate blood containing organs. For example, a wound of the heart made after death may cause a leakage of blood, by gravity alone, from the heart along bullet tract to the pleural cavity producing a hemothorax, and the blood in the pleural cavity may leak out a wound of exit and stain the surrounding clothes. There is no evidence, however, of arterial squirting.

I have seen a cisternal puncture, made twenty minutes after death, mimic exactly an antemortem wound, there being a blood clot sealing the puncture wound in back of neck and extensive underlying hemorrhage infiltrating the tissues along the needle tract.

In multiple bullet wounds of the body a careful autopsy usually discloses which one was fatal. There may be two, three or more fatal wounds all, or any one alone, producing death by hemorrhage and shock. On the other hand, insignificant wounds in the extremities or body walls that did not cause or influence death, may have, if the victim lived, become infected and prove fatal. This should be remembered when testifying as to fatal wounds.

Part II. Death from Cutting and Stabbing

Homicidal Cutting and Stabbing

This has always been a common mode of murder. In this country it has been replaced largely by shooting which does not expose the murderer to a close fight with his victim.

Murder by cutting and stabbing is still, however, frequent among the American negro, being much more popular than shooting. Many of the victims show scars of a former encounter, usually with marked keloid formation.

In 360 homicides in Essex County during an eight year period (1925–1932) there were seventy deaths from cutting and stabbing, forming 19 percent of the total homicides.

In 2,457 homicides in New York City during a five year period (1928–1932) there were 499 murders by cutting and stabbing, or 20 percent of the total homicides.

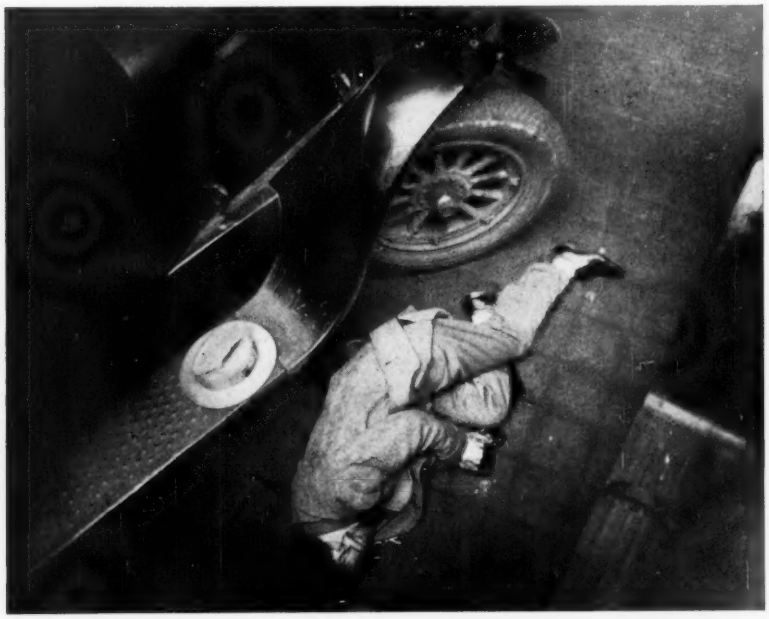

FIG. 1. VIEWING BODY AT SCENE OF CRIME—HOMICIDE BY SHOOTING "PUT ON SPOT"

Showing position of body when found. Shot twice in back of head and twice in left neck. Note two revolver wounds of entrance in left neck with powder marks beneath left ear. Shots at fairly close range (coup de grâce). (Office of Chief Medical Examiner, Essex County, N. J.)

At the present time, therefore, murder by cutting and stabbing forms about 20 percent of the homicides in and around the Metropolitan district and is only exceeded by shooting and assault. Furthermore, such homicides are seven times more frequent than suicide by cutting and stabbing. Therefore, every

case must be investigated with the same care as if murder was committed.

Cutting

In homicide by cutting the murderer most frequently attacks the throat, inflicting incised wounds or cuts. When the throat

FIG. 2. VIEWING BODY AT SCENE OF CRIME—HOMICIDE BY SHOOTING—"TORCH MURDER"

Stolen seven passenger sedan used in taking gangster for "a ride." Victim shot in back of head and alcohol poured over body and set afire while still alive. Note charred remains of gangster. Autopsy required 18 hours. Police bulletin with accurate description of teeth, approximate age, height and weight of body, etc., mailed to over 30,000 dentists. Identified through teeth. (Office of Chief Medical Examiner, Essex County, N. J.)

is cut, the knife or razor is usually drawn clean across the front of the neck with considerable force, the murderer standing in back or to one side of the victim.

The edges are cleanly cut, straight, curved or zigzag, and

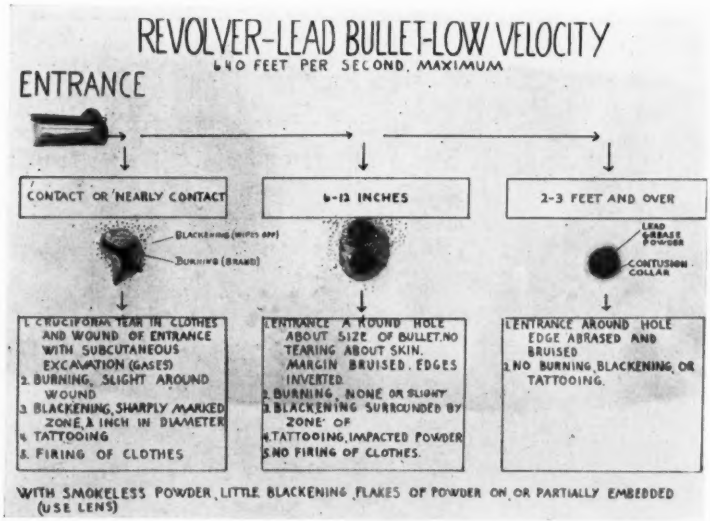
REVOLVER-LEAD BULLET-LOW VELOCITY
640 FEET PER SECOND, MAXIMUM
ENTRANCE
CONTACT OR NEARLY CONTACT
6-12 INCHES
2-3 FEET AND OVER
BLACKENING (WIPES OFF)
BURNING (BRAND)
LEAD & GREASE POWDER
CONTUSION COLLAR
1. CRUCIFORM TEAR IN CLOTHES AND WOUND OF ENTRANCE WITH SUBCUTANEOUS EXCAVATION (GASES)
2. BURNING, SLIGHT AROUND WOUND
3. BLACKENING, SHARPLY MARKED ZONE, ½ INCH IN DIAMETER
4. TATTOOING
5. FIRING OF CLOTHES
1. ENTRANCE A ROUND HOLE ABOUT SIZE OF BULLET. NO TEARING ABOUT SKIN. MARGIN BRUISED. EDGES INVERTED
2. BURNING, NONE OR SLIGHT
3. BLACKENING SURROUNDED BY ZONE OF
4. TATTOOING, IMPACTED POWDER
5. NO FIRING OF CLOTHES.
1. ENTRANCE AROUND HOLE EDGE ABRASED AND BRUISED
2. NO BURNING, BLACKENING, OR TATTOOING.
WITH SMOKELESS POWDER, LITTLE BLACKENING, FLAKES OF POWDER ON OR PARTIALLY EMBEDDED (USE LENS)

FIG. 3. DIAGRAM ILLUSTRATING WOUNDS OF ENTRANCE MADE BY REVOLVERS AT VARYING DISTANCES

(Office of Chief Medical Examiner, Essex County, N. J.)

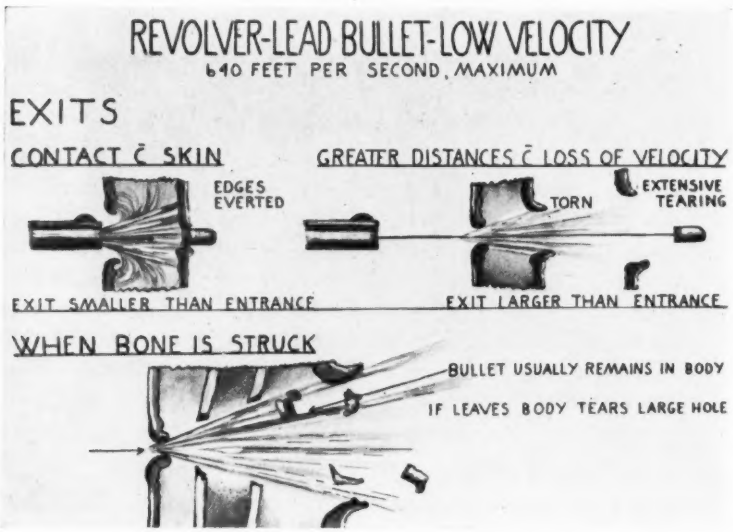

FIG. 4. DIAGRAM ILLUSTRATING REVOLVER WOUNDS OF ENTRANCE AND EXIT

(Office of Chief Medical Examiner, Essex County, N. J.)

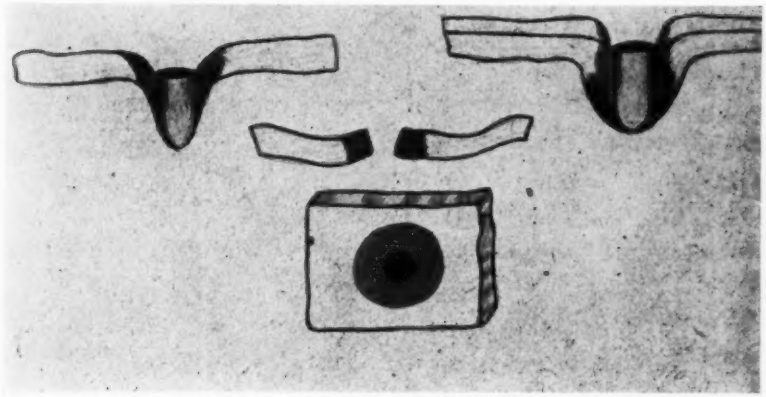

FIG. 5. SCHEMATIC REPRESENTATION OF THE PRODUCTION OF THE CONTUSION COLLAR IN WOUNDS OF ENTRANCE WHERE THE BULLET STRIKES THE SKIN AT RIGHT ANGLES

After Borri—Trattato di Medicina Legale. (Office of Chief Medical Examiner, Essex County, N. J.)

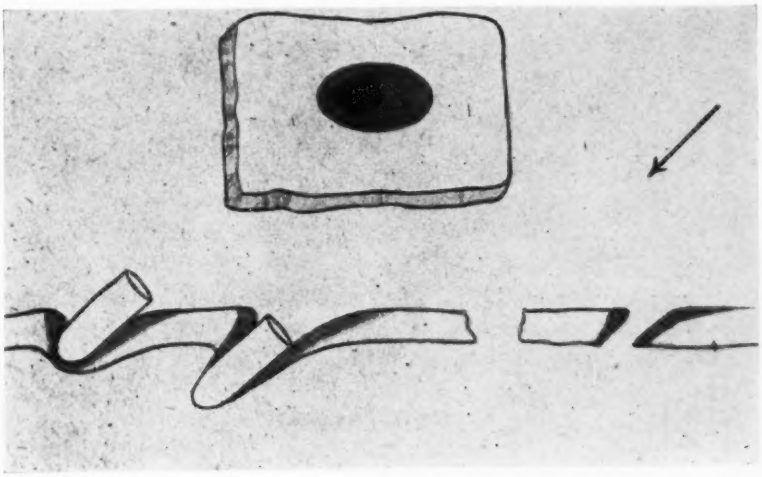

FIG. 6. SCHEMATIC REPRESENTATION OF THE PRODUCTION OF THE CONTUSION COLLAR IN WOUNDS OF ENTRANCE WHERE THE BULLET STRIKES THE SKIN AT AN OBLIQUE ANGLE

After Borri—Trattato di Medicina Legale. (Office of Chief Medical Examiner, Essex County, N. J.)

often everted. The wound gaps widest in its middle, especially if it cuts directly or obliquely across muscle tissue.

Most of the important structures of the neck may be severed, the knife often making a cut or scratch across the bodies of the cervical vertebrae or their intervertebral discs, and the head appearing as if almost decapitated.

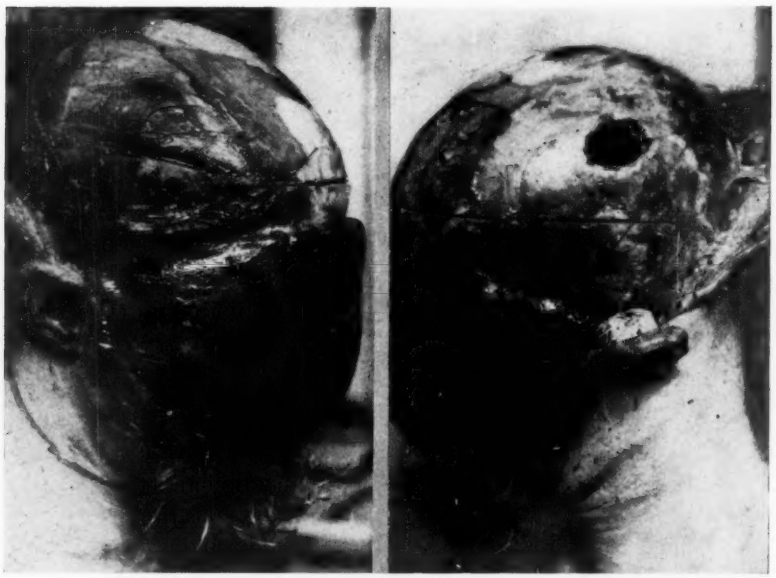

FIG. 7. BULLET WOUND OF SKULL—SUICIDE

Deceased shot himself during pursuit by police after committing homicide. Note wound of entrance in right temporal region, a small punched out wound of outer table. This wound is beveled on inside. Note wound of exit over left parietal boss, a larger wound beveled externally. (Office of Chief Medical Examiner, New York City.)

One or both carotid arteries and internal jugular veins may be partially or completely severed, and evidence of arterial bleeding and squirting may be seen about the body and its surroundings. We have seen carotid squirting in a homicide, spray the ceiling of the room with innumerable droplets of blood. The ends of the severed carotid arteries are often found markedly retracted

in the wound. If the jugulars are cut, air bubbles are frequently found in blood of the right heart. In most of these cases death is practically instantaneous from hemorrhage.

On the side of the neck a homicidal cut may sometimes extend across the cervical spine and sever the well protected vertebral artery, a very difficult cut for a suicide.

FIG. 8. CONTACT AND NEAR CONTACT REVOLVER WOUNDS OF CHIN AND NECK—HOMICIDE BY SHOOTING

Note large lacerated wounds of entrance due to subcutaneous excavation by explosive gases. Most of powder smudge and burning, and tatooing is in the wounds themselves. The wound towards the midline, however, shows considerable tatooing of skin and is a near contact wound. (Office of Chief Medical Examiner—New York City.)

Often more than one cut is made. Cuts may cross each other and form large ragged flaps of skin and tissue, but there never will be found the delicate "hesitation marks" of a suicide.

Very often the neck and face will not be the only part of the body attacked; the trunk and extremities may show extensive cutting and stabbing. Frequently cuts may be seen over the fingers, hands, wrists and forearms, due to a struggle by the victim

FIG. 9. CONTACT REVOLVER WOUNDS OF FACE—HOMICIDE BY SHOOTING—GANGSTER

Note two wounds of entrance larger than diameter of bullet with no surrounding powder burns or tatooing, and impression of muzzle and rib of pistol on skin. Muzzle and rib of pistol correspond with impressions on face shown on insert. (Office of Chief Medical Examiner—New York City.)

in an attempt at defense. In an erotic murder we have seen as many as ninety-five separate cuts and stabwounds scattered over the entire body. There may be large cuts on the abdomen with partial evisceration.

In vendetta and gangster murders the murderers may finish

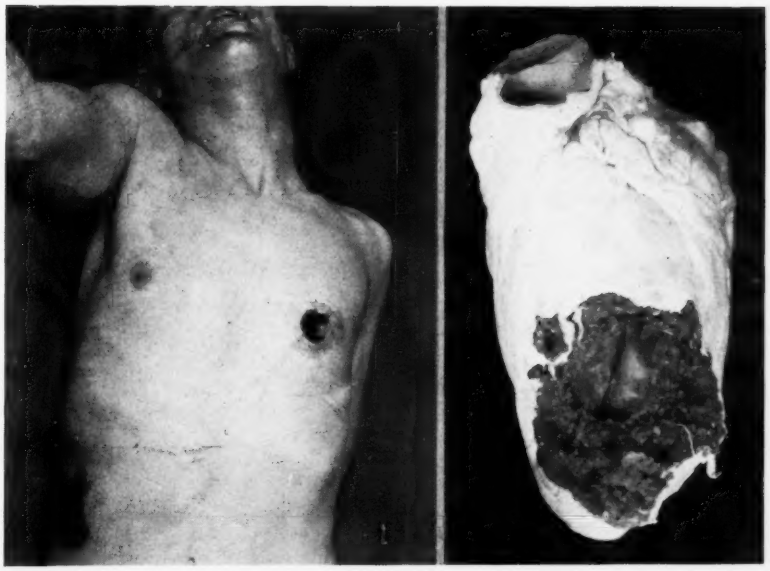

FIG. 10. CONTACT REVOLVER WOUND OF LEFT CHEST—SUICIDE BY SHOOTING

Note large wound of entrance with powder burn of skin and extensive laceration of heart with embedded black powder in heart muscle. (Office of Chief Medical Examiner—New York City.)

FIG. 11. CLOSE-UP REVOLVER WOUND OF FOREHEAD—HOMICIDE BY SHOOTING IN SPEAKEASY

Note close-up bullet wound of forehead with brand (flame burn) of skin eccentricly placed, tatooing, and shriveled burned hairs. The direction of the trigger of the gun was directly opposite the brand. Distance about 4″. (Office of Chief Medical Examiner—New York City.)

the attack by drawing the knife across the face making a single or double cross, or cutting down into corner of the mouth—the so-called squealer's cut.

FIG. 12. MULTIPLE REVOLVER WOUNDS OF FACE AND NECK—HOMICIDE BY SHOOTING—GANGSTER

Note large contact wound on cheek with practically no surrounding powder burns or mark, and close-up wound on chin with extensive tatooing of surrounding skin, also close-up wound on neck with powder smudge and powder grains above line of collar. The surrounding skin over last wound is burned due to firing of clothes. (Office of Chief Medical Examiner—New York City.)

Stabbing

In stabbing the wound is a *punctured* one which penetrates the skin and enters the body to a variable extent. The wound of entrance on the skin is a narrow one, while the tract in the body tissues is usually a long one.

In stabbing, the blows are usually directed at the chest or

abdomen, rather than at the throat, with the idea of striking the heart or other vital organs. Stabwounds are often made from the back or side of the victim.

Insignificant stabwounds near the right or left border of the sternum frequently sever the internal mammary arteries producing hemothorax.

FIG. 13. HOMICIDE BY SHOOTING—GANGSTER TAKEN FOR "A RIDE"

Shot in back of head by gunman in rear seat. The position is typical of "a ride victim." The bleeding from the left ear is due to fracture of base of skull. (Office of Chief Medical Examiner, Essex County, N. J.)

Likewise apparently insignificant wounds made by penknives in Scarpa's triangle may sever the femoral artery.

Often repeated stabs may be made. These wounds may sometimes be delivered in rapid succession over a small limited section of the body. In an argument over a card game an old man re-

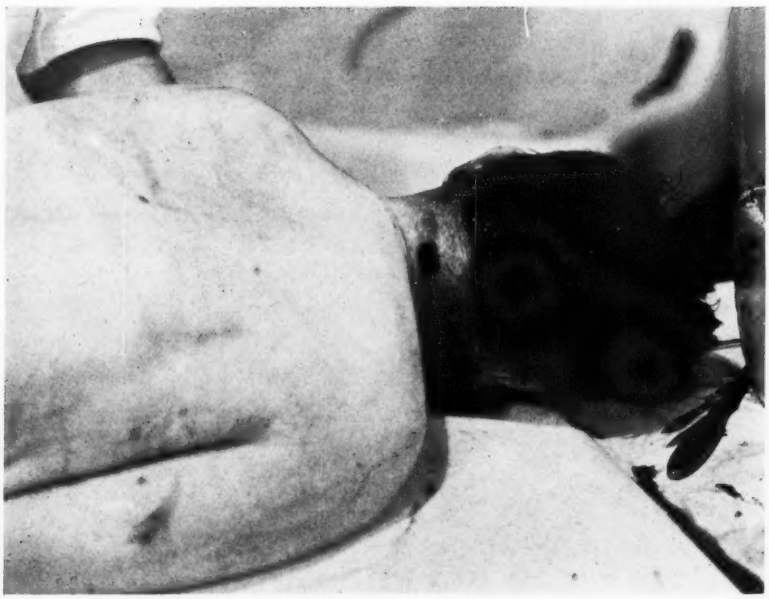

FIG. 14. BULLET WOUND OF ENTRANCE IN HOMICIDE SHOWN IN FIGURE 13

The blackening and burning of surrounding skin due to a close shot may be noted. (Office of Chief Medical Examiner, Essex County, N. J.)

FIG. 15. HOMICIDE BY SHOOTING. WOUND OF NECK MADE BY BULLET FIRED FROM A DISTANCE

On the left—wound of entrance with contusion collar and absence of burning, blackening and tatooing may be noted. On the right—the larger torn wound of exit. (Office of Chief Medical Examiner—New York City.)

ceived nineteen stabwounds in his body. In another case thirty-two stabwounds were made apparently with an ice pick over a small area on the abdomen.

Stabwounds

If a sharp instrument such as a knife is used and the blow is perpendicular to the surface of the body, the skin wound is usu-

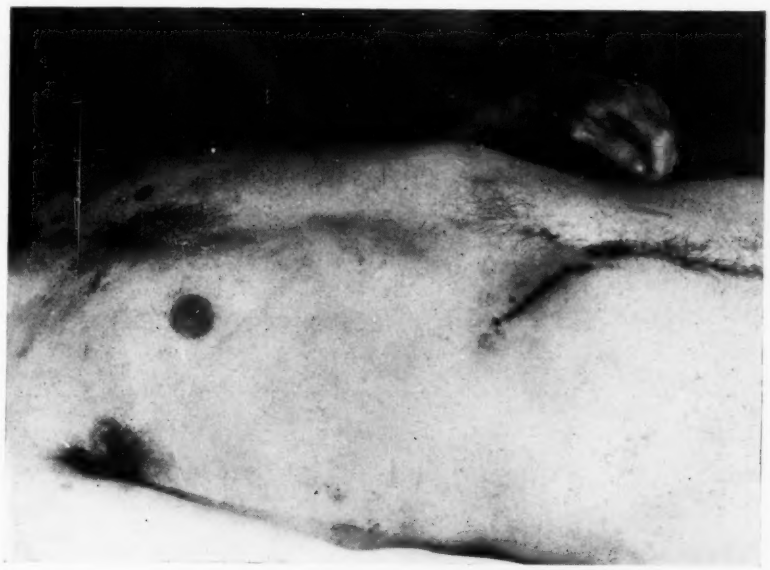

FIG. 16. HOMICIDE BY SHOOTING—BULLET SLAP OF ABDOMEN

To the right of the umbilicus is a tangential linear superficial brush abrasion of skin made by bullet which did not enter body. The fatal wound may be seen in the left upper chest. (Office of Chief Medical Examiner—New York City.)

ally a little larger than the widest part of the knife blade which has entered the body, as there is often a slight increase made in withdrawing the knife, or the blade may have entered at an oblique angle. Such wounds are usually elliptical in shape, gaping widest in their middle, with similar appearing ends in which the edges meet at acute angles. The wound is rarely wedge-shaped because of the elasticity of the skin. If, however, a knife

blade with a broad back penetrates a flat bone or cartilage, or solid viscus such as the liver, a wedge-shaped wound is sometimes seen.

FIG. 17. SUBMACHINE GUN BULLET WOUNDS—GANGSTER "PUT ON SPOT"

Note multiple 45 caliber bullet wounds of head, body and extremities made at short range. Note extensive destruction of underlying tissues due to eccentric whirling of butt of bullets at this range, with fracture of right humerus. Also ploughing of tissues where bullets struck at angles. (Office of Chief Medical Examiner—New York City.)

Frequently in stabwounds there may be very little blood seen over the body or its surroundings, the bleeding being mainly internal. When examining the body at the scene of the crime

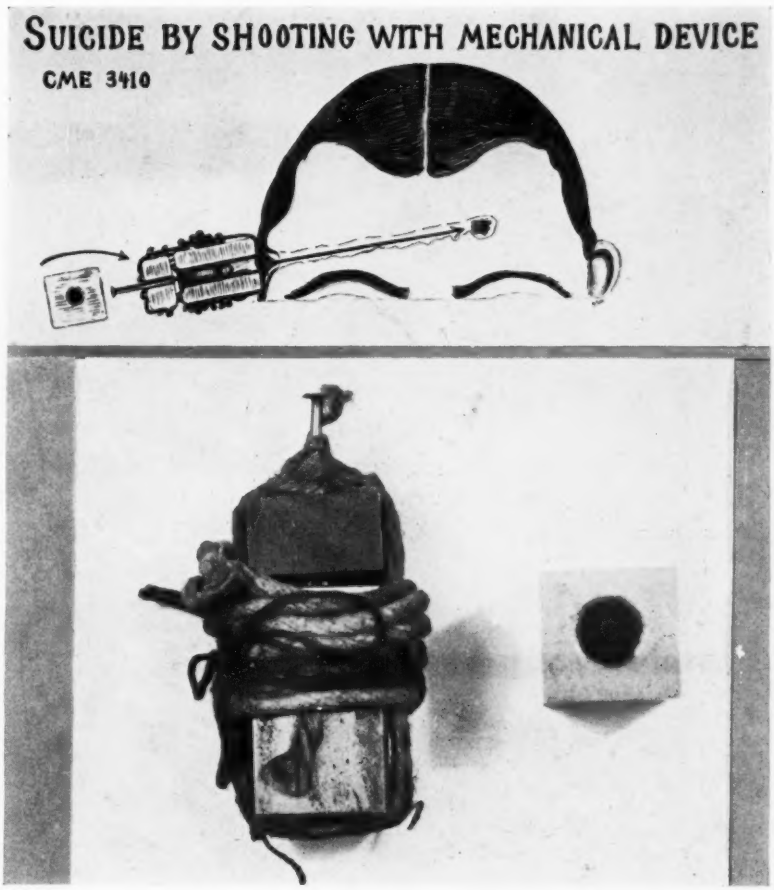

FIG. 18. SUICIDE BY SHOOTING WITH A MECHANICAL DEVICE

The suicide, a patient in an insane asylum, possessed a 38 caliber lead cartridge without the knowledge of the authorities. The patient, an ex-machinist, asked his brother, also a machinist, who was visiting him, to make the steel blocks. These metal blocks were supposedly to be used in the manufacture of wicker chairs in the occupational therapy department. The cartridge was put in the device which was then assembled with string and discharged. An ordinary nail was used as a firing pin. (Office of Chief Medical Examiner, Essex County, N. J.)

FIG. 19. MATRICIDE BY SHOOTING WITH WINCHESTER 45–70 RIFLE AT A DISTANCE OF ABOUT TWO FEET

The wound of entrance in left temple, with extensive burning and blackening, may be noted. (Office of Chief Medical Examiner, Essex County, N. J.)

FIG. 20. SAME CASE AS FIGURE 19

The lacerated wound of exit with strand of tissue protruding externally through wound may be noted. (Office of Chief Medical Examiner, Essex County, N. J.)

this may give a false impression that the murder has been committed elsewhere.

If the stabwounds are made with small instruments such as needles, an icepick, et cetera the wounds are usually round and the shape of the weapon, but frequently due to gaping of the

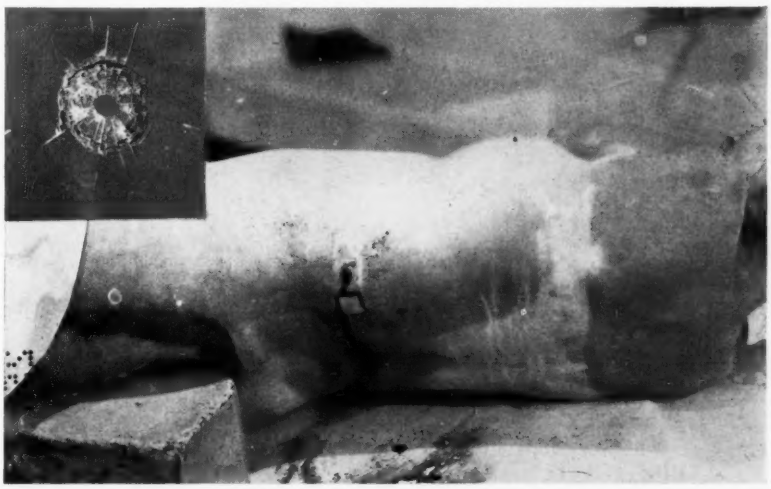

FIG. 21. HOMICIDE BY SHOOTING WITH 22 CALIBER RIFLE BY BOYS "POTTING" WINDOWS AT NIGHT

A bullet wound of entrance over region of left kidney causing death from internal hemorrhage may be noted. The rifle was fired at a distance of about 100 yards. The victim was in the bathroom near a window with the shade drawn, when bullet entered. Insert shows bullet hole in window. By methods of triangulation from the bullet wound in body, bullet hole in bathroom window, and bullet holes in neighboring houses, place of shooting was traced to an attic window 100 yards away. (Office of Chief Medical Examiner, Essex County, N. J.)

elastic skin, are a little larger in diameter than the weapon that made them.

If a butcher's steel or larger instrument is used, instead of a round wound there may be a linear stabwound, or an irregular or even triangular wound, frequently smaller in diameter than

the instrument producing it, due to contractility of the surrounding skin.

A careful examination of the edges of the surrounding skin should be made. Sometimes when knives are driven into the body with great force, a characteristic abrasion, pattern or laceration made by the hilt or other part of the knife, may be noted. This may help in the identification of a suspected weapon.

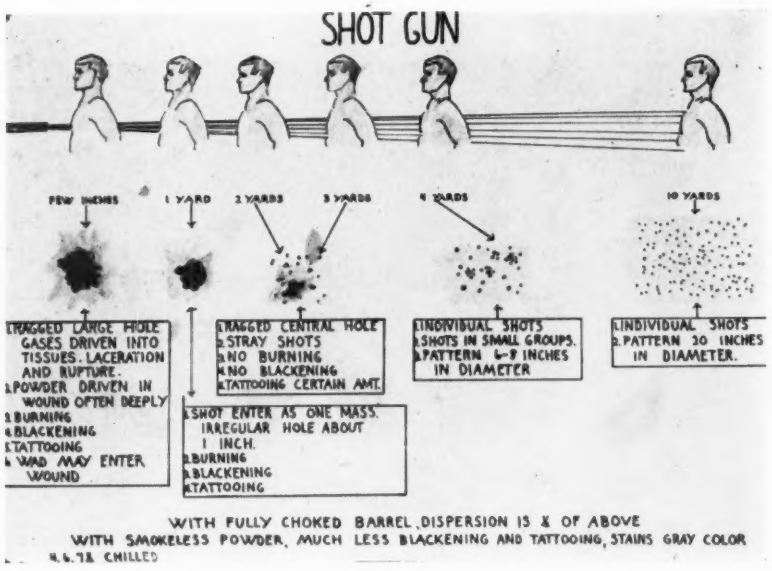

FIG. 22. DIAGRAM ILLUSTRATING WOUNDS PRODUCED BY A SHOTGUN AT VARYING DISTANCE

(Office of Chief Medical Examiner, Essex County, N. J.)

It will be seen that the greatest caution is necessary in forming an opinion or guess as to the character of the weapon used in stabbing. Only very general statements are safe and therefore, the signing of death certificates should be in a noncommittal manner. They are official records and may be introduced in court. For instance, one may safely state: "Homicide by stabbing, multiple stabwounds of chest penetrating heart, made with *sharp instrument.*"

Depth of stabwounds

Likewise the greatest caution must be taken in estimating the depth of a stabwound, unless the tip of the knife has stopped in some fixed part of the anatomy such as a bone. Under such circumstances the depth of the wound may equal the length of the weapon.

FIG. 23. HOMICIDE BY SHOOTING—SHOTGUN—STREET BRAWL

Note funnel-shaped wound of entrance in chest with scattering of small number of shot above wound. Range about four feet. Multiple lacerations of heart and kidneys. (Office of Chief Medical Examiner, Essex County, N. J.)

Frequently the estimated depth of the wound at necropsy may be greater than the length of the blade of the weapon. This is often seen in stabwounds of the heart when the heart is nearer to the anterior chest wall in the erect position of the body at the time of stabbing, than in the prone position of the body at necropsy. Furthermore, the force of the blow may depress soft parts and allow a short blade to go a greater distance, as is often seen in wounds of the abdomen.

At necropsy the same care should be taken as in bullet wounds to accurately describe the position of the wounds. They should be photographed and their course in the body and the structures injured should be described. The depth of a wound is measured from its point of entrance in the skin to the deepest part reached by the weapon, which is often in viscera which have a considerable

FIG. 24. HOMICIDE BY SHOOTING—SHOTGUN

While walking along street shot in back by insane person, distance of about 30 feet. Over 370 No. 8 bird shot entered body, many penetrating lungs and abdomen. Note pattern about 20 inches square over back of body. (Office of Chief Medical Examiner, Essex County, N. J.)

normal mobility in the body. Then maximum and minimum estimates of the probable depth of the wound should be made.

Search should always be made in the wounds, especially where bone is struck, for broken pieces of the weapon. They may fit exactly into a suspected weapon. However, such occurrences are rare.

Weapons used. In judging the nature of the weapon used it

FIG. 25. HOMICIDE BY SHOOTING—SHOTGUN

Shot with shotgun in drunken brawl. Over 200 No. 7 bird shot entered back of both knees lacerating both popliteal arteries and veins. Died from hemorrhage on arrival at hospital. Intoxicated. (Office of Chief Medical Examiner, Essex County, N. J.)

FIG. 26. HOMICIDE BY SHOOTING—SHOTGUN

Note nine wounds of entrance made by "00" slugs. (Office of Chief Medical Examiner—New York City.)

should be borne in mind that a hatchet, cleaver or razor will make incised wounds, but a razor will not cut into bone. A blow on the head with a pipe or sharp board may split the scalp and resemble a cut, but on careful examination often brownish, parchment-like linear brush abrasions may be noted along the margins of the wound. Bullets may make tangential splits in the skin that appear like cuts.

Homicidal assaults

Space does not permit a discussion of wounds produced by such weapons as hatchets, axes, hammers, et cetera, which often cause incised or punctured wounds. The great weight of these weapons and the violence with which they are used usually inflict wounds about which there is little argument.

Among the Chinese in their tong wars, hatchet murders are considered the orthodox style of killing. The murderer is usually paid a higher fee than for shooting or stabbing his victim.

The presence of blood or hair of the victim on suspected weapons is the work of the toxicologist or crime detection laboratory.

SUICIDE BY CUTTING AND STABBING

Suicide by cutting and stabbing is on the decrease, being greatly exceeded by inhalation of illuminant gas, hanging and jumping from buildings.

In 1,056 suicides in Essex County during an eight year period (1925–1932) there were only thirty-eight by this method, forming but 3 percent of the total cases.

In 7,219 suicides in New York City during a five year period (1928–1932) 241 were by cutting and stabbing, forming also only 3 percent of the total suicides.

Suicides usually cut themselves, stabbing being much more uncommon. The most frequent locations are the throat and wrists, often a combination of both. The weapon used in cutting is usually a sharp knife, butcher knife, razor or safety razor blade. If the latter superficial cuts on the hand using the instrument may be sometimes noted.

A right handed man in cutting his throat usually starts the cut high up on the left side of his neck below the angle of the jaw. Frequently, but not always, he will make one or more, sometimes five or six, superficial scratches or deeper cuts before letting the knife go across the front of his neck. These are typical "hesitation marks" characteristic of suicide. The cut usually extends across the front of the neck slanting downwards from left to right, or in a horizontal manner. If the cut is deep enough the carotid vessels on the left side of the neck may be severed. The cut then usually passes across the top of the thyroid notch or lower, crossing the anterior triangle of the neck on right side, often severing the carotid vessels on this side. It usually stops near the anterior border of the sternomastoid muscle where two to four deep serations may sometimes be seen. Left handed suicides will usually cut in the opposite direction.

It must be remembered that in ambidextrous people, a man thought to be right handed (because he writes with his right hand) may use his left hand in cutting his throat.

One or both wrists may be cut, the cuts practically always being situated over their anterior surfaces about one to two inches above the wristjoint. There may be only a few, one to three, superficial or deep cuts which sever radial arteries. More often there are many parallel superficial scratches and cuts (hesitation cuts), sometimes fifteen to twenty or more. Curiously these hesitation cuts often do little harm and he is forced to finish the job by other means.

In some cases multiple attempts are made. In one case the victim stabbed himself repeatedly in the scalp and then cut his throat. Failing at this he hung himself with a leather belt. The belt broke and his body in falling knocked off a gas fixture causing death by asphyxiation.

Weird and unusual stabbing methods sometimes occur. In one case a despondent patient stabbed himself through a craniotomy wound. Of course, in all suicidal stabbing cases the location and direction of the wound must be compatible with suicide.

ACCIDENTAL CUTTING AND STABBING

Accidental cutting causing death is sometimes seen. Children may cut themselves while playing with fragments of broken glass, pottery, et cetera. I had one case of a child who while running with a bottle of milk, fell and drove a large sharp piece of glass into his abdomen producing internal hemorrhage.

In another case a child was accidentally stabbed through the perineum by the stalk of an old umbrella placed by other children at the bottom of a playground slide.

In adults, fencing accidents have occasionally resulted in death. In one of my cases the foil entered the orbit and penetrated the brain. The two fencers had removed their masks and were just demonstrating a new thrust.

In industry, various accidental cuttings may cause death by injuries to body and extremities. These have been greatly reduced, however, by the activities of safety councils, and other agencies. In one case a long splinter of wood flying from a buzz saw produced a stabwound of the abdomen causing death.

Part III. Violent Death from Asphyxia

Asphyxia is the result of interference with the respiratory function whereby the vital organs and tissues are prevented from obtaining the supply of oxygen essential to life.

Asphyxia may be due to either mechanical causes preventing the entrance of oxygen into the lungs; to injuries and diseases interfering with the movements of respiration; to the presence of irrespirable gases, or to causes acting upon the respiratory centers such as alcohol and certain poisons.

GENERAL PICTURE OF ASPHYXIATION AT NECROPSY

External examination

The body usually shows a face which is cyanosed. The lips, fingernails and ears are bluish in color and may be almost black. The eyes bulge and the conjunctivae are reddened and suffused. Petechial hemorrhages may be seen in the skin, especially over the face, forehead, neck, and commonly in the palpebral and ocular conjunctivae.

FIG. 27. HOMICIDE BY CUTTING THROAT

Note clean cut made by knife drawn across throat of victim. Also note absence of hesitation marks as seen in suicidal cut throats. (Office of Chief Medical Examiner, Essex County, N. J.)

FIG. 28. HOMICIDE BY CUTTING

Old lady murdered by maniac. Multiple slashes of throat severing carotid vessels. (Office of Chief Medical Examiner, Essex County, N. J.)

The tongue more frequently lies behind the teeth, or if protruded, is caught between the firmly locked teeth. Postmortem lividity over the dependent parts of the body is marked, and due to venous distention the picture of cyanosis predominates. However, in some cases there may be pallor instead of cyanosis.

The cooling of the body may be delayed. Rigor mortis usually sets in early as it does in most sudden deaths.

FIG. 29. HOMICIDE BY CUTTING AND STABBING—EVISCERATION

Murdered by maniac. (Office of Chief Medical Examiner, Essex County, N. J.)

Internal examination

The right heart is overdistended with fluid blood which is a very dark color (except in carbon monoxide poisoning) and contains no clots. The left heart is contracted and empty. The large veins of the superior mediastinum are enormously distended with dark fluid blood.

The lungs usually well fill the pleural cavities, their anterior

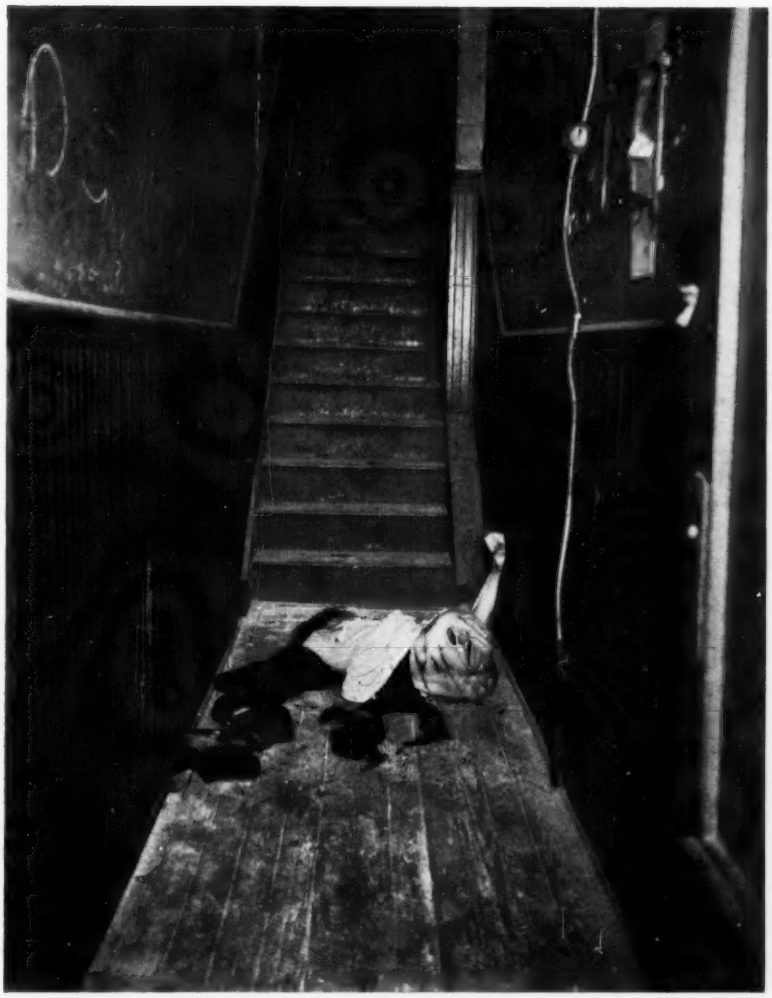

FIG. 30. EROTIC MURDER—STABBING AND CUTTING—SCENE OF CRIME

Body of Indian girl lying in hallway of tenement house. Multiple stab-wounds of chest and throat causing death from hemorrhage. (Office of Chief Medical Examiner, Essex County, N. J.)

borders often meet or overlap in the midline opposite the third rib. Blebs of acute interstitial emphysema may be noted over the external surfaces of the lungs, especially over their anterior

edges and external margins at their bases, where often rows of minute blebs occur. In some places actual rupture of these vesi-

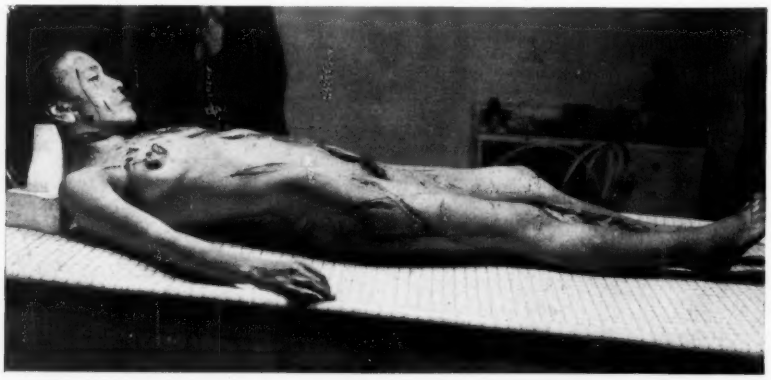

FIG. 31. BODY OF VICTIM SHOWN IN FIGURE 30

Body shows over 95 stabwounds and cuts, most of them made after death. Note absence of bleeding in most of the cuts. (Office of Chief Medical Examiner, Essex County, N. J.)

FIG. 32. THE SAME BODY SHOWN IN FIGURE 31

(Office of Chief Medical Examiner, Essex County, N. J.)

cles occurs with a resultant suffusion of air beneath the pleura, probably due to spasmodic expiratory efforts. On section, the lungs are often bloody and markedly congested. The bronchial

FIG. 33. HOMICIDE BY CUTTING AND STABBING

Stabwound of right upper chest severing internal mammary artery, hemothorax. Superficial cut across right arm. (Office of Chief Medical Examiner, Essex County, N. J.)

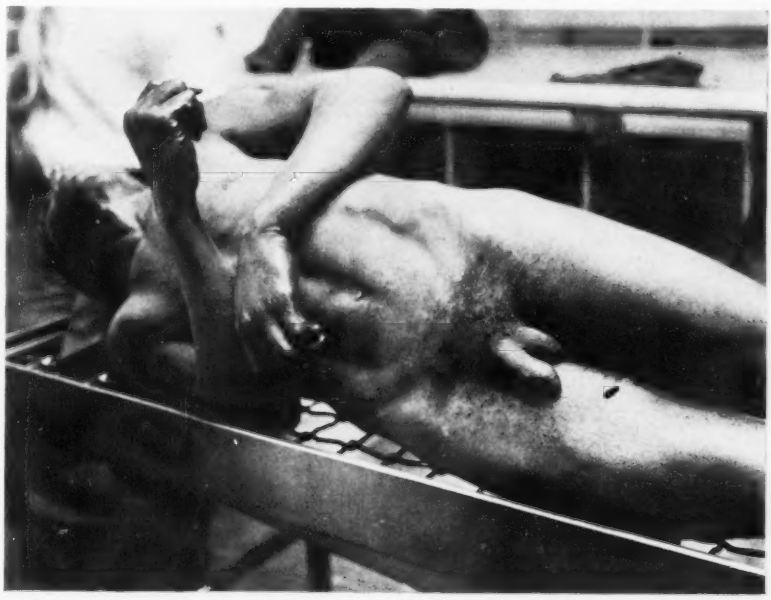

FIG. 34. HOMICIDE BY STABBING WITH PEN-KNIFE

Note small incised wound in lower part of Scarpa's triangle on right side. Severance of femoral artery. Dead on arrival at hospital. (Office of Chief Medical Examiner, Essex County, N. J.)

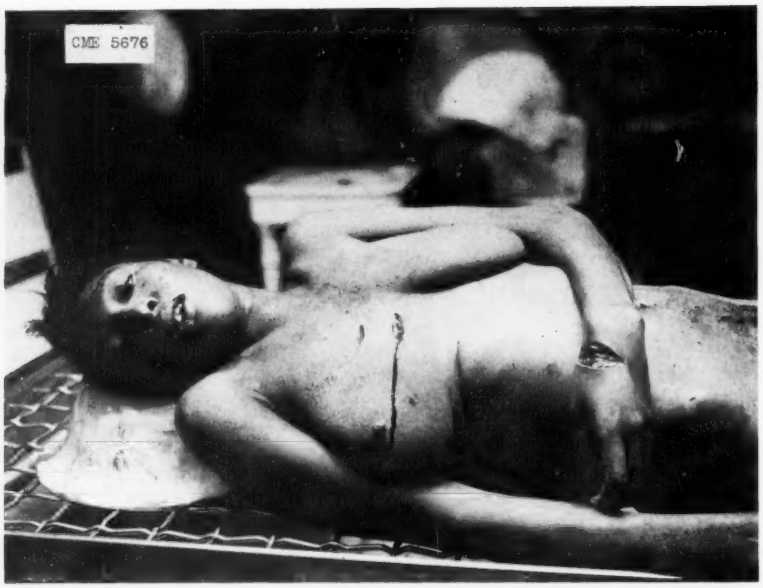

FIG. 35. HOMICIDE BY STABBING AND CUTTING

Note two stabwounds of chest penetrating heart, and superficial cut across outer aspect of left wrist received in struggle. (Office of Chief Medical Examiner, Essex County, N. J.)

FIG. 36. INCISED WOUND OF FACE AND NECK—HOMICIDE

Note large cut across left side of face and neck made by murderer. The posterior end of the cut is deep, leading down to the vertebra with severance of the well protected vertebral artery. Death from hemorrhage. (Office of Chief Medical Examiner—New York City.)

FIG. 37. MULTIPLE STABWOUNDS—HOMICIDE

Note multiple small stabwounds of chest (32 wounds) penetrating heart, such as might be made with ice-pick, file, stiletto, or similar instrument. Body found submerged in bath tub. (Office of Chief Medical Examiner—New York City.)

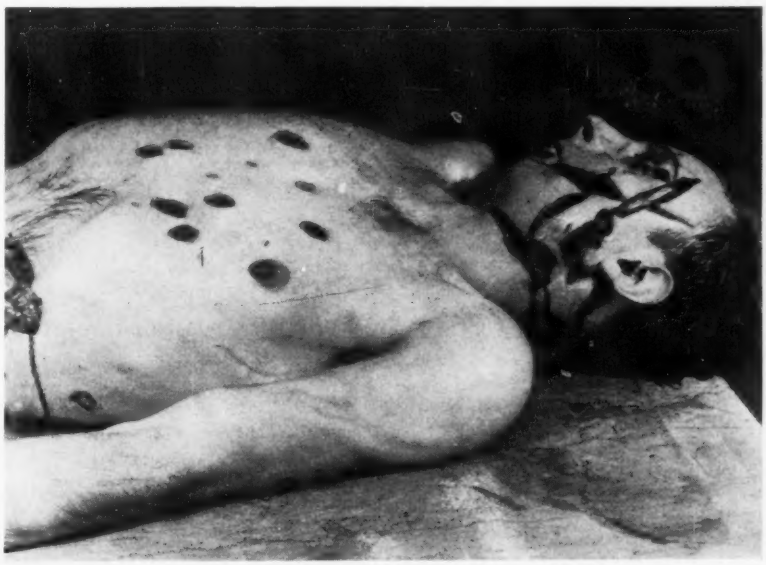

FIG. 38. WOUNDS BY STABBING AND CUTTING—HOMICIDE

Note multiple stabwounds of chest, disembowelment and a double cross vendetta wound on face, the lower cut simulating the so-called "squealer's cut." (Office of Chief Medical Examiner—New York City.)

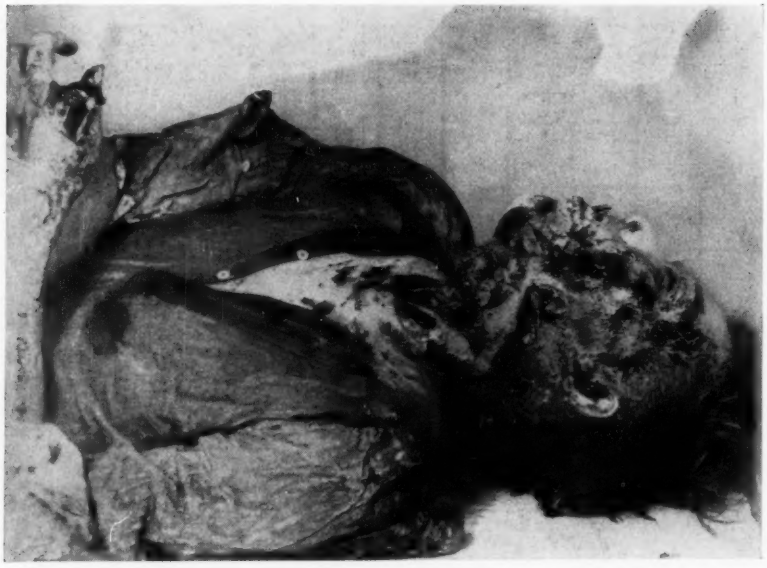

FIG. 39. WOUNDS MADE WITH AXE—HOMICIDE

Note severance of left side of neck, chopped mandible and left index finger. At autopsy 18 hours after death, right auricle was found beating. (Office of Chief Medical Examiner—New York City.)

FIG. 40. HOMICIDE BY ASSAULT—AXE MURDER

Head recovered from river about two weeks after murder. While intoxicated, struck in back of head with axe fracturing skull. Body dismembered with saw and axe into nine parts, eight of which were recovered, some several miles apart. (Office of Chief Medical Examiner, Essex County, N. J.)

FIG. 41. SUICIDE BY CUTTING THROAT WITH RAZOR

The cut in this case started on left side of neck and was finished on right side, being made with the right hand. Note numerous chops and "hesitation cuts," characteristic of suicide. (Office of Chief Medical Examiner, Essex County, N. J.)

FIG. 42. SAME CASE AS IN FIGURE 41

Showing right side of neck where cut ended. (Office of Chief Medical Examiner, Essex County, N. J.)

FIG. 43. SUICIDE BY CUTTING THROAT AND WRISTS WITH RAZOR

The "hesitation cuts" on left side of neck where cut was started may be noted. (Office of Chief Medical Examiner, Essex County, N. J.)

FIG. 44. SAME CASE AS IN FIGURE 43

Showing multiple razor cuts on both wrists with an occasional hesitation mark. (Office of Chief Medical Examiner, Essex County, N. J.)

mucosa may be intensely congested. An acute edema is sometimes noted, microscopic examination showing rupture of the interalveolar septa and distention of the alveoli with fluid which contains neither leucocytes or fibrin.

FIG. 45. WOUNDS BY STABBING AND CUTTING—MULTIPLE ATTEMPTS AT SUICIDE

This man cut his throat and stabbed himself numerous times over head, using his right hand. Being unsuccessful in severing any large artery, he then hanged himself with a leather belt which broke. While falling he knocked off the tip of a gas fixture and was asphyxiated by illuminant gas. (Office of Chief Medical Examiner—New York City.)

Subendothelial ecchymoses, varying in size from 1 mm. to 1 cm. in diameter, may be found over the parietal and visceral pleura, the mediastinal pleura, the visceral and sometimes the parietal pericardium, the endocardium, the meninges and more rarely the peritoneum. These are valuable signs of asphyxia but must be distinguished from similar appearing hemorrhages occurring

in sepsis, purpura, nephritis and some of the poisons, notably arsenic and phosphorus. In cases of slow or very rapid asphyxiation no ecchymoses may be found. They are almost constantly found in overlaying.

FIG. 46. SUICIDE BY STABBING

Note stabwound over left parietal region made by left handed person in committing suicide. The stabwound passes through an old craniotomy opening directly into brain, the scar of healed skin flap being visible. (Office of Chief Medical Examiner—New York City.)

Asphyxial hemorrhages in the scalp are often seen in hanging and strangulation cases. The brain and pia-arachnoid is usually engorged with blood, the veins being prominent and distended. The grey matter is often a purplish hue. Occasionally asphyxial hemorrhages may be noted in the meninges and parenchyma of the brain.

The abdominal viscera, especially the liver, spleen and kidneys

are dark red in color and filled with blood. The gastrointestinal tract is often cyanosed.

In some cases of sudden occlusion of the larynx by a foreign body, such as a piece of meat, laryngeal tumor, or in some individuals who fall or are thrown into cold water, death may occur very suddenly, apparently by reflex paralysis of respiration. Again, in some cases of hanging or strangulation sudden paralysis of respiration and heart action may take place due to compression of the vagi. In such cases, there may be absence of cyanosis, excessive hyperemia and ecchymoses, making the cause of death, at times, a difficult one to determine.

When most of the above picture is present, it is typical enough to form the opinion that death was the result of asphyxia. When only a few of the signs are present the correct interpretation is often difficult.

Whether the asphyxia was due to violence or only a mode of death during the course of a disease cannot be stated unless evidence of the asphyxiating cause is found, such as, water in the lungs in drowning, mud in the nose and mouth in smothering, a piece of meat in the larynx in choking or the presence of a high concentration of carbon monoxide in the blood in illuminant gas poisoning.

ASPHYXIA DUE TO MECHANICAL CAUSES

In asphyxia due to mechanical obstruction breathing is prevented, the tissues in consequence are depleted of oxygen (anoxemia) and retain an excess of carbon dioxide.

Smothering

Smothering is defined as being a closure of the external respiratory orifices, namely, the nose and the mouth, produced either by the hands or by other means.

From the viewpoint of the medical examiner the more frequent types of smothering occur during infancy.

Overlaying. A baby may be overlaid by the mother either accidentally or with homicidal intent. Overlaying is common amongst the poor where the parents and the infant sleep in the

same bed, especially when the parents are intoxicated. In such cases, the body may show little or no evidence of external injuries; however, there may be a slight or marked cyanosis especially of the head, neck, finger nails, et cetera, or the presence of bloody mucus in the nostrils and mouth.

Postural smothering. On the other hand, a baby may be accidentally smothered by the pillow or bed clothes, often in the crib, by turning over in sleep or during an unexplained convulsion.

Infanticide. In a similar manner, homicidal smothering may be accomplished by holding or pressing a soft pillow or bed clothes over the baby's face leaving practically no external marks of injury.

The external examination of the body in all these cases will be practically the same, there may be no external marks of injury or merely a flattening of the nose and cheeks as a result of pressure. The pallor over the compressed parts accentuate the surrounding lividity. Bloody mucus or froth may be found in the nostrils or mouth, often staining the underlying bed clothes.

The necropsy shows the general picture of death from asphyxia, sometimes pronounced and at other times less definite. In smothering, more than in any other type of asphyxial death, small asphyxial petechial hemorrhages may almost invariably be found over the parietal and visceral pleura, the visceral pericardium or in the mediastina, tissues, meninges or peritoneum.

Accidental smothering in adults. In healthy adults accidental smothering by bed clothes or postural smothering by turning the head into the pillow is practically impossible as the person, by reflex action, wakes up and throws off the obstructing clothes. It may occur, however, in acute alcoholism, status epilepticus or in debilitated or dying persons.

Suicidal smotherings. For similar reasons suicidal smothering is rare since the individual can seldom hold anything over his mouth or nose long enough. On the other hand, self-strangulation by means of a ligature is not uncommon, since the compressing ligature produces rapid loss of consciousness. I had one case of an old lady who, by holding a wad of cotton containing a

little chloroform over her face, smothered herself, death being due to asphyxiation.

Homicidal smothering. Smothering by means of cloths, or other materials, is unusual except in infanticide or in weak persons. In healthy adults, a struggle usually taking place, the murderer has to resort to some other means. External injuries received in the struggle are therefore apt to be found.

Homicidal smothering by means of applying the hands to the face and mouth is more common and is known as "burking." This method of murder originated during the "resurrection days" when anatomists, to obtain cadavers, were compelled to deal with grave-robbers. In 1827, Burke and his partner Hare supplied bodies for the famous Edinburgh anatomist, Robert Knox, by murdering unfortunates in this manner. They usually threw their victims to the ground and knelt on their chests with the whole weight of the body while one hand was clapped over both the nose and the mouth, the other held the jaws firmly pressed together. Death usually took place in three to four minutes, leaving very few external marks of injury. To one untrained in this technic, however, more or less typical marks of injury may be seen around the nostrils, lips, and other exposed parts.

Other methods. Finally, smothering may take place, usually accidentally, by falling into mud, sand, ashes, water, et cetera. I examined the body of a man who by falling into a large hopper filled with fine wood shavings, was smothered; the entire upper respiratory tract as far down as the finer bronchi contained wood shavings. In another case there five men were overcome by arseniuretted hydrogen while cleaning a waste pit, death was due to smothering by the mud at the bottom of the pit.

STRANGULATION

Asphyxia by strangulation is due to a closure of the air passages by external pressure on the neck.

Three main types of strangulation may be described:

1. Hanging.
2. Strangulation by ligature.
3. Throttling or manual strangulation.

Hanging

In hanging, the body is completely or partially suspended by means of a rope, wire, belt, strap, sheet, et cetera, placed around and constricting the neck by weight of the hanging body.

Suicide, murder or accidental? Hanging is almost always suicidal. It ranks next to illuminating gas as a means of committing suicide.

In New York City during a five year period (1928–1932) there were 1,044 suicides by hanging, only six due to accident and none due to homicide. Hanging formed 14 percent of the total 7,219 suicides.

This should not cause the medical examiner to quickly and carelessly dispose of all hanging cases as suicidal without a careful investigation. Murder by hanging must be very rare since it requires at least the help of another person unless the victim has been previously rendered unconscious by means of other injuries, drugs or poisons.

Suspension of the body to simulate suicide after murder has been committed, is more common than murder by hanging. The investigation and necropsy must show that the hanging occurred postmortem and that some other violence or poison had produced death.

Smith states that the presence of ecchymoses about the mark of the ligature, a red line of rupture of the intima of the carotid arteries and the presence of definite ecchymoses or areas of extravasated blood are the only reliable signs that the body was suspended during life. A colored zone at the edges of the furrow may be due to postmortem hypostasis and is not reliable. Practically all the other signs of hanging have been produced experimentally by Smith. The depression of the tissues by the ligature is much the same whether the body is suspended before or after death.

Of course the examination at the scene of the death may give clues of great value. For instance, in a case reported by Smith in which the victim had first been strangled and the body later suspended, although the feet were two feet above the floor, there was neither table nor chair from which he could have stepped.

Accidental hanging is unusual and in our experience has occurred chiefly in children who were playing cowboy, bandit, and other such games. The history and examination of the scene of death usually clears the case. Some of the children have undoubtedly committed suicide however, but have been given the benefit of the doubt. Occasionally a child may be accidentally suspended by a neck band of clothing from a projecting railing or by falling, catch his neck between the palings of a fence and hang.

Suicidal hanging. By far the commonest way of committing suicide by hanging is to stand on a chair or box, adjust the loop or running noose about the neck and kick the support over.

The downward pull of the body causes the rope to be pulled upwards to the highest position possible on the neck where it is usually stopped by the angles of the jaw. In front, the rope lies between the thyroid cartilage and the hyoid bone, on the sides just under the angle of the lower jaw and below the ears and behind, runs across the scalp where it reaches the highest point.

In such cases, where there has been no appreciable drop and therefore no injury to the spine and medulla, the general constriction of the neck causes partial or complete compression of the great vessels of the neck, interfering with the cerebral blood supply and causing rapid unconsciousness. The entrance of air into the trachea is prevented by the closure of the glottis, by the upward and backwards displacement of the tongue, soft palate, and other structures, with the production of asphyxia. Compression of the vagus nerves may cause cardiac inhibition.

The rapidity with which consciousness is lost is sometimes possible to evaluate by noting the hand of the victim to be still in the noose or one foot still on the chair or stool.

To account for death in these hangings where no "drop" occurs, pressure on the blood vessels of the neck, pressure on the nerves, and mechanical obstruction to breathing have been proposed, separate and exclusive claims having been made for each. In still other contributions it is admitted that two or all three of these major effects may aid in causing death, and contentions have arisen over the significance to be assigned to each.

It is generally accepted that the soft palate, tongue and larynx

are pushed up and back so as to cut off the respiration effectively when junction of the body and its suspensor are in the typical position on one side behind or otherwise close to one ear. Access to air, it has been shown, has not been obstructed in persons who have hung themselves after tracheotomy, the tubes still being in place below the loop. In some of the ancient forms of execution, the trachea was cut or stabbed before the criminal was suspended by the neck.

Observations have been made of a short stoppage of the heart due to irritation of the vagi at the moment of suspension; the inability to resuscitate persons cut down almost at once has been accounted for in this way. Others have called attention to the superficial location of the superior laryngeal nerves and their important connections with cardiac ganglions and nerve plexuses. In these hangings death usually results in from five to ten minutes after consciousness is lost, even though the heart may continue to beat for eight or ten minutes after the cessation of respiration. In view of this latter fact resuscitation is possible, and artificial respiration should be started not later than five or six minutes after suspension.

From the above it will be seen that most authorities consider asphyxia by hanging as due to a combination of these three major factors, the death being not one of pure asphyxiation. I am somewhat skeptical about this. My experience has been that the main factor in these hangings is asphyxiation due to closure or shutting off of the air passages and that all other factors are usually of secondary or contributory importance.

That this is not more clearly recognized is due to the fact that the anatomical relationship of the structures in the mouth, nasopharynx, and glottis cannot be demonstrated by the ordinary necropsy technic.

In the cases of suicidal hanging where I have taken the trouble to split the head in a vertical transverse manner, (after the brain has been removed, by sawing through the middle of the basillar portion of the occipital bone and exposing the nasopharynx from the rear or by making median sections of the entire head and neck) I have repeatedly demonstrated complete obstruction to the air passages.

In suicidal hanging it is not necessary that the body be completely suspended. Suicides often hang themselves in a sitting or reclining position with the feet and even the entire body on the floor, only a comparatively slight traction being required to produce asphyxiation. Usually in these cases the mark of the ligature is lower down than when the body is suspended, often below the thyroid cartilage and the furrow sometimes runs almost horizontally around the neck.

Necropsy. In suicidal, accidental and homicidal hangings, in which there is no "drop," the following may be found at necropsy:

Furrow or constriction mark. This is by far the most important and often the only absolute sign of hanging.

If the body is completely suspended the lowest part of the furrow is usually in front, above the thyroid cartilage, and its course will depend on the position of the knot. A convergence of the furrow behind one or the other ear, under the angle of the jaw on either side, under the chin, or under the occiput denotes the position of the knot which is usually the highest part of the furrow.

When a fixed loop is used the head is tilted to the side opposite the open end of the loop, the furrow being deepest and most marked on the side opposite the knot, and gradually inclining upwards in an oblique manner towards the knot. Marks produced by the knot are often absent, since if the loop is a loose one there will be no pressure of the knot against the skin. There may be only the converging ends of the furrow with an area of unmarked skin separating them.

When a running noose is used the same position of the head results, the furrow, however, is usually less oblique and the marks of the knot are often seen since it is pressed tightly into the skin.

If the body is only partly suspended the course of the furrow is, as a rule, more circular and in front lies lower often below the thyroid cartilage.

If the ligature is a rope or of hard material, a single or double furrow is seen whose depth is pale, and whose margins are congested, hyperemic and occasionally show a few ecchymoses especially on its upper border, proving that suspension took place

during life. On drying the furrow often becomes brown in color and parchment-like.

If the ligature is soft, such as a sheet or scarf, one may find only a broad pale depression which may disappear in time and leave practically no mark.

If a belt or suspenders were used, the marks of the buckles may sometimes be recognized.

External examination of body. The face above the furrow is often pale, however, if the strangulation has been slow and not too tight, resulting in first the compression of the veins before the deeper arteries, marked cyanosis may be present above the ligature.

The position of the tongue behind or in front of the teeth in the mouth depends entirely on the relation of the ligature to the hyoid bone and the direction of the traction.

Saliva often dribbles from the mouth when the head is tilted forward due to pressure of the ligature on the salivary glands.

If the body has hung for some time, the blood settles into the lower extremities and the most marked lividity may be seen below the waist, the upper part of the trunk being pale. Even petechial hemorrhages may occur in the legs in this manner.

It is a common belief that an erection of the penis with discharge of semen occurs in hanging. Gravity alone will account for the engorgement of blood in the penis and the leaking of fluid from the seminal vesicles.

Internal examination of body. Just as the external marks of constriction on the neck form the main diagnostic signs of hanging, so the effects of this constriction on the neck form the most important findings at necropsy. The other findings only establish that death was or was not due to asphyxia without determining its cause.

I have found in most cases of hanging that the direction of the constricting force which is almost always upwards and backwards pulls the hyoid bone with the base of the tongue backwards and upwards. The normal space between the base of the tongue and epiglottis is obliterated so that the base of the tongue lies in apposition with the anterior surface of the epiglottis. The epi-

glottis is pushed backward so that its posterior surface is in apposition with the posterior pharyngeal wall effectively blocking the glottis. The soft palate and uvula is pushed backwards and upwards, its posterior or superior surface coming in apposition with the posterior pharyngeal wall effectively blocking the passages of air from the nasal cavities.

As death has occurred with the parts in these positions they may be found months after burial provided the body is fairly well preserved.

The position assumed by the tip of the tongue usually depends on the relation of the ligature to the hyoid bone and the direction of the traction. If the ligature comes just below the hyoid the tongue is forced upwards and slightly backwards, its tip being forced forwards so that it may either protrude through the lips, be caught between the teeth or, if the jaws are firmly closed, behind them. If, however, the ligature is very high and the main pressure is above the hyoid, the base of the tongue is forced upwards and backwards and the tip will be found behind the teeth pulled well back into the mouth. This same position occurs when the ligature is very low and the traction is more circular.

In addition to the position of the parts described above, there may be found in the dissection of the neck, evidence of contusion, laceration and hemorrhage in the tissues underlying the area of compression.

The tissues directly under the ligature may be dry, pale, compressed or show ecchymoses. Fibers of the platysma may be torn. The trachea may be compressed and some of its rings broken, the thyroid cartilage may be fractured, especially its posterior horns. The hyoid bone which is often fractured in high manual strangulation escapes injury in hanging.

Laceration of the intima of the carotid arteries at the site of compression is sometimes seen producing a transverse tear. The mucosa of the trachea, epiglottis and nasopharynx may show ecchymotic hemorrhages and be markedly hyperemic and bloody mucus be found in the nasopharynx.

Often many of these signs are missing or present to only a slight degree, especially when hanging occurs by means of softer liga-

tures. The position of the parts in the throat, however, will almost always be found. Occasionally, but not often, in hanging with the loop of knot placed behind the ear, and with sudden tension of the body weight upon the noose, fracture or dislocation of the atlas upon the axis, with crushing of the medulla by the odontoid process, occurs, and death is instantaneous. The findings above described in such cases may be absent. In addition the necropsy usually shows the general findings of asphyxiation none of which alone are characteristic.

Judicial hanging. In many of the States hanging is the official method of execution and when performed properly by using the "drop" and allowing the body to fall some two or more feet, the sudden jerk on reaching end of rope causes dislocation or fractures of the spine and rupture of the cord. Death is instantaneous and is not due to asphyxia unless the hanging is poorly done. The heart may beat for several minutes and muscular convulsions may set in after a few minutes of quiet.

In lynching by hanging, the rope is usually placed around the neck and the other end thrown over a tree or pole, the victim is then pulled up until his feet are several feet above ground. Death usually occurs by slow asphyxiation with marked cyanosis of face.

Strangulation by ligature

Strangulation means a constriction of the neck with a ligature, the force being applied directly to the ligature. The mark encircles the neck, and is lower and more horizontal than in hanging. The ligature presses directly upon the larynx and asphyxia almost alone results.

Murder, suicide or accidental? Strangulation is a fairly common form of murder. Often the murderer uses much force and injuries to deep structures may be found together with other evidence of violence. The tearing of clothes and surrounding evidence of a struggle is often found. The ligature may be found around the neck or it may have been removed. If present it should be photographed before removal and the knot should never be untied as it may form the most important evidence

against the murderer. The ligature can be readily cut off while still preserving the knot.

In New York City in a five year period (1928–1932) there were thirty homicides by strangulation with a ligature, only four suicides and no accidental strangulations.

Suicide by strangulation is usually accomplished by tying a handkerchief, shoe-string, cord, wire, necktie, belt, or suspenders around the neck. As a rule several turns are made and then a knot is tied. In spite of the fact that consciousness is lost very rapidly, the suicide ties a firm knot. Or, he may use a stick of wood, spoon or other object and turn a loose noose around, in tourniquet fashion, which is not able to untwist after he falls, the compression still being maintained.

In suicide the ligature should be found on the neck and no signs of other violence or marks of a struggle should be seen.

Prisoners often commit suicides by hanging themselves in their cells by means of belts, suspenders or neckties so that in well regulated prisons these articles are taken away or do not form a part of the prison uniform.

Accidental strangulation is only occasionally seen, occurring especially in children in play who may be caught in window sashes, cords or ropes. The surrounding circumstances and history is usually plain.

Necropsy. As the ligature is not so suddenly applied as in hanging, the large veins of the neck are compressed before the arteries and the face is more frequently cyanotic, often blue or black, swollen, eyes bulging, asphyxial petechial hemorrhages in the conjunctiva, in the skin of the face, in the scalp, protrusion of tongue with indentations from teeth and blood stained mucus in the mouth and nostrils.

In murder where greater constriction usually occurs extensive laceration and hemorrhage in the deeper tissues may be found. Fracture of the larynx and rings of the trachea may be seen. The general picture of an asphyxial death is usually more marked than in other forms of asphyxiation. The petechial asphyxial hemorrhages in the pleura, pericardium, and blebs of acute interstitial emphysema in the lungs are almost always present and

usually pronounced. All the important organs are engorged with dark fluid blood. Putrefaction takes place rapidly often confusing the picture. The best preserved tissues will be found directly under the compressed area where definite hemorrhage may still be seen in such cases.

Furthermore, if a very soft cloth has been used, external marks on the neck and laceration and hemorrhage in the tissues of the neck may be absent or slight in extent.

Throttling or manual strangulation

Manual strangulation is always homicidal. It would be difficult to conceive of a suicidal or accidental throttling by means of the hands.

In New York City, in a twelve year period (1918–1930) in a total of 3,340 homicides investigated by the Chief Medical Examiner's office, Gonzales[4] reported twenty-four cases of manual strangulation or 0.7 percent of the total homicides, indicating the comparative rarity of this form of violent death. Nineteen, occurred in adults, from twenty-three to sixty-eight years of age and five in newborn infants at full term. Of the adults fourteen were females. The bodies were found under a variety of conditions, in rooms, hallways, cellars, et cetera. No instances of precipitate death from irritation of cervical nerves could be demonstrated.

Grasping a person by the throat is quite common in ordinary fights in attempted robbery and rape. Since it is done very quickly, often in a sudden fit of anger, the throat may be held a little too long. There is, as a rule, no premeditation. For this reason it is usually difficult for the prosecuting attorney to obtain a conviction higher than second degree murder or manslaughter, the jury often even freeing the murderer. Strangulation by a ligature, however, as, for instance, in a case of a wire wrapped around the neck indicates premeditation resulting often in first degree convictions.

In all these cases the same careful examination by the medical examiner at the scene of the crime is essential, with a description of the surroundings, the position of the body and clothing, the presence of external marks of injury, rigor mortis, and other facts.

Autopsy. External examination. Distinctive cervical scratch marks and contusions were uniformly present in the cases reported by Gonzales, with the exception of one in which hemorrhage in the deep cervical fascia and a fracture of the hyoid bone established the manner of death.

It is therefore, important, that a careful examination of the neck be made for scratch marks and contusions which from their characteristic semilunar shape may suggest finger and thumb nail injuries. Their number, situation and general arrangement may often tell whether one or both hands were used, whether a high or low manual strangulation and whether strangulation took place from in front or rear of the victim. Bruises on the back and the sides of neck may denote counter-pressure by the other hand.

Often other marks of violence may be seen around the head, face, breasts, lips, arms and hands as the victim is usually a healthy adult and unless rendered unconscious by a blow, or intoxicated or drugged, will put up a fight. Ribs may be broken due to the murderer kneeling on the body. Consciousness, however, is rapidly lost in most cases and there may be no violent struggle.

Usually external evidence of asphyxiation is well marked. The head and face are cyanotic, the face often swollen and almost black, the tongue often protrudes and is firmly caught between the teeth, the finger tips are cyanotic and often numerous asphyxial petechial hemorrhages may be found over the shoulders back and chest.

Internal examination. In my cases of manual strangulation I have used necropsy technic which was demonstrated to me several years ago by Schultze.

After a careful description of the external appearance of the body, photographs are made of the marks of violence about the neck, the body is then opened in the orthodox manner. By this examination death from asphyxia is usually established since these cases show a well pronounced general picture of asphyxia. Asphyxial hemorrhages in the pleura and pericardium, areas of acute interstitial emphysema and engorgement of the right heart with dark fluid blood is marked.

The head is next examined, often numerous asphyxial hemor-

rhages may be found in the scalp sometimes innumerable over the entire scalp. The brain is then removed. The pia-arachnoid vessels are usually distended with dark blood and occasionally petechial hemorrhages may be found in the meninges or the parenchyma of brain.

The base of the skull is then split transversely by sawing through the middle of the basilar portion of the occipital bone and the nasopharynx is opened from behind.

The position of the parts in manual strangulation in those dying with the hands of the murderer still on the throat, will be almost identical with that found in suicidal hanging. The air passages will be completely blocked by the base of the tongue being shoved backward and slightly upward, the epiglottis closing the glottis, its posterior surface in apposition to the posterior pharyngeal wall.

As to whether the tip of the tongue moves forward and protrudes between the teeth or falls backward and remains in the mouth, depends entirely on the position and direction of the compressing force in relation to the hyoid bone. During this examination accurate measurements of the parts may be taken and a photograph made. The extreme congestion of the mucosa of the nasopharynx with asphyxial hemorrhages in laryngeal mucosa and over the epiglottis, and the presence of bloody mucus or froth may be noted.

The scalp incision is then extended down the anterior borders of sternomastoid muscles and the neck dissected and explored for contusions, lacerations and hemorrhage. Fracture of the thyroid cartilage in its lateral alae, of the cricoid in its thin arch, and of the hyoid bone in its great horns may be noted. Fracture of the hyoid bone is usually seen only in high manual strangulation. In Gonzales' series, however, it only occurred four times. Smith warns against mistaking the normal joint between the body and the great horns of the hyoid, which only disappear by ossification in middle age, for a fracture. Injuries to the trachea and its rings are infrequent because of the high position of strangulation.

Usually there will be found in the deeper layers of the skin, areolar tissue, fascia and muscles over the course of the carotid vessels, hemorrhagic contusions with an occasional hemorrhage

in the thyroid or submaxillary gland. Thin sheet-like hemorrhages over the course of the carotid vessels are often seen but never have I found an internal rupture in the arteries.

The lesions in infants (infanticide) are similar to those found in adults.

In those who use the ordinary autopsy technic, the position of the parts in manual strangulation will never be found. Gonzales in a criticism of these postural findings states

> The assumption that bilateral compression forces the tongue into the nasopharynx, disturbs the relations of the epiglottis and uvula, and approximates the vocal cords was not substantiated in his series. Conceding their diagnostic importance in hanging and in throttling by ligature, when the constriction remains until rigor mortis is established, their persistance after release of pressure presupposes the immediate onset of rigor and a disregard for the natural elasticity of the laryngeal cartilages.

Furthermore he claims the diagnosis of manual strangulation must rest upon the presence of such cardinal signs as the characteristic bilateral lesions of the skin, deep-seated hemorrhage and injuries to larynx or to hyoid bone. The absence of one or more of these proportionately increases the uncertainty.

I have maintained, however, that the position of the parts which have repeatedly been found in these cases has very little to do with the elasticity of the laryngeal cartilages, with perhaps the exception of the epiglottis, and that they stay in these positions due to the soft, mushy tongue being crowded back and holding them in this position.

CHOKING

Many include under the term "choking" all cases of fatal asphyxiation due to occlusion of the respiratory passages by solids, liquids or gases and also lesions in the air passages and their walls due to disease. This would include a great variety of conditions such as impaction of a foreign body in the throat, drowning, the inhalation of irrespirable gases and choking the result of cancer of larynx, et cetera.

I prefer to limit the term, in medical examiner's work, to the obstruction of the respiratory passages by solid foreign bodies.

Choking is practically always accidental. Insane persons may commit suicide by forcing solid substances into their throats. Solids have been forced into the throat of a victim for the purpose of murder. These cases, however, are rare.

Choking is common in infancy, where regurgitated milk may spill over into larynx, frighten the child and be aspirated into the smaller bronchi by spasmodic inspiratory efforts.

It is quite common in children, who have the habit of putting small objects of every description in their mouths. Attempts at speaking and swallowing at the same time, or crying out with foreign bodies in their mouths favor choking.

It is common in adults, in gourmands or hungry men, who quickly bolt large pieces of food, to have particles stick in the larynx or esophagus and press against and close the glottis. Tobacco or false teeth may lodge in the throat and produce rapid asphyxia. Smaller objects, such as fish bones, may lodge in the throat and cause asphyxia from spasm of the glottis caused by fright and edema produced by irritation.

Finally, vomitus may drain over into the larynx and, by inspiratory attempts, be aspirated into the smaller bronchi and cause asphyxiation. This is especially common in acute alcoholism and occasionally occurs during epileptic fits and in poorly administered anaesthesia. In cases of death from natural causes, a terminating asphyxia is the mode of death in many common diseases, aspirated vomitus being often found in the smaller bronchi. This must be distinguished from the stomach contents falling into the larynx due to postmortem purging; such contents will not reach the smaller bronchi.

Necropsy. Necropsy usually disclosed a more or less well defined picture of asphyxiation and the asphyxiating object is found in the respiratory tract. In persons dying with spasm of the glottis the general signs of asphyxiation may be absent.

DROWNING

Drowning is a form of asphyxial death caused by complete or partial submersion of the victim in water or other fluid. While in most cases complete submersion occurs, it is only necessary

to have enough water to cover the nostrils and mouth to produce death.

Accident, suicide or murder? From the viewpoint of the medical examiner most drownings are accidental. Homicide by drowning is rare. In New York City in a five year period (1928–1932) there were 2,257 drownings classified as accidental, only 153 suicides and only three murders.

Whether drowning is accidental or suicidal, in cases in which there are no witnesses, can only in a few instances be determined by medical examination of the body. The correct interpretation usually depends on collateral evidence, which is often vague and frequently missing. Therefore many cases which are undoubtedly suicides are signed out as accidental when there is no proof of suicide. This greatly increases the number of accidental drownings.

Necropsy. External examination. In a body recovered shortly after death any of the following findings may or may not be found: Body cold, pale with firm rigor; postmortem lividity most marked in head and chest, since the head is usually the most dependent part in water; conjunctivae suffused, eyes, prominent and often conjunctival hemorrhages; cutis anserina or goose flesh with retraction of the male genitals; bleaching, and corrugation of skin of hands and feet; the mouth usually open with presence of an extremely fine, frothy, not blood stained foam in the nostrils and mouth which increases on pressing the chest, and occasionally the presence of weeds, gravel or other foreign material firmly grasped in hands.

Internal examination. Necropsy usually shows enormously, inflated, pale, wet and soggy lungs which entirely fill pleural cavities, their anterior borders often overlapping; presence of fine, not blood stained froth and fluid in the trachea, bronchi and bronchioles with hydraulic overdistention of the alveoli with air and blebs of acute interstitial emphysema over the free borders of lungs; absence of pleural ecchymoses; lungs which on section are wet and pale and in fluid of which there may be sometimes found silt, mud, algae, et cetera characteristic of the water from which the body was recovered; the right heart and large veins

are distended with dark fluid blood, and considerable water in the stomach which often passes down into the duodenum and upper jejunum may be found.

When most of these findings are present presumptive evidence of drowning is justifiable. Smith[8] states that only a few of the findings are, however, of distinct diagnostic value, they are:

(1) Fine, frothy foam in mouth and nose.
(2) Foreign material, such as weeds, stones, et cetera firmly grasped in hands.
(3) Fine, frothy foam and fluid in trachea and bronchi.
(4) Overinflated, soggy lungs with watery exudate on section.
(5) Presence of water in stomach.

Most of these, however, are not absolute and they can be mimmiced by other conditions. Froth and frothy fluid in mouth, nostrils and air passages may occur in pulmonary edema from a variety of causes and simulate that found in drowning; in my cases of drowning, probably due to the character of the river and ocean waters, it is rare to find weeds, et cetera in the hands of the victim. Well inflated wet lungs may be seen in pulmonary edema from many causes and may not be an outstanding feature in many cases of drowning. Finally, the victim may have drunk considerable water before submersion.

Furthermore, in bodies which have been in water for a longer period of time, these findings may entirely disappear or be masked by putrefaction so that a diagnosis as to the cause of death is impossible.

It will be seen, therefore, that since there are no absolute findings in drowning, the diagnosis depends upon the presence of one or several of the above findings which, if present, suggest death from drowning.

The blood chloride test devised by Gettler,[2] however, represents the only positive sign of drowning and in my experience is in most cases the only reliable information.

Normally the chloride content of the blood in the right and left chambers of the heart is about equal. When a person drowns water does not enter the lungs in any considerable quantity until the stage of terminal asphyxiation takes place, at which time

ballooning of the lungs occurs and water enters the bronchioles leading to distention of the alveoli with residual air. This period takes a considerable time to pass through and is associated with automatic respiratory efforts. Practically all drowning cases must pass through this period.

The entrance of water into the lungs dilutes the blood in the left side of the heart by a method of osmosis. No water can enter the left heart if the body is dead when thrown into the water. When drowning occurs in salt water the chloride content of the left heart will be higher than that in the right heart by as much as from 19 to 294 mg. per 100 cc. of blood (Gettler's cases) and when drowning occurs in fresh water the chloride content of the left heart will be lower than that found in the right heart.

Unfortunately in bodies which have been in water for long periods of time or in which rapid putrefaction takes place no blood can be obtained for the chemical test, the right side of the heart containing only a few gas bubbles. Such cases, especially in hot weather, often form a considerable number of the drowning cases.

Furthermore, in cases in which very little struggle occurs and consequently little water enters the lungs, the typical findings of drowning may be slight or absent, and the chemical test be inconclusive or entirely negative.

It is said that people who are intoxicated, drugged or rendered unconscious by injuries may die in water without much of a struggle. Finally the older literature contains many isolated cases in which spasmodic closure of the glottis occurs as the result of water entering the mouth and nose or from a nervous reflex due to sudden chilling of the body. Death in such cases is said to take place quickly, the victim sinking at once. These cases, however, are admitted to be rare, even by the advocates of this theory. I have always been skeptical about them and do not believe that many would stand critical review. In all such cases, however, the diagnosis of drowning would be extremely difficult and often could not be made.

Space does not permit a discussion of the physiology of drowning. Problems such as the length of time the body has been in the water, the unusual cases of submersion after death and both suicidal and homicidal submersions will be omitted.

SUFFOCATION

Asphyxia by suffocation should be limited to deaths caused by blocking of the respiratory tract from within.

Violent deaths from suffocation are often due to the presence of foreign matter in nose, mouth and respiratory tract and are usually caused by accidental falls in mud, sand, coal, dust, sawdust, flour, et cetera. They may be caused by aspiration of vomitus in acute alcoholism.

Many of the causes of suffocation have already been described under smothering as the two conditions often overlap. For instance, a person smothered by falling in mud may have both nose and mouth obstructed and at necropsy aspirated mud in the finer bronchi may be demonstrated, making the case one also of suffocation.

Suffocation occasionally occurs in children from inhalation of zinc stearate powder. I had one case of a moribund patient suffering from a malignant stricture of the esophagus, suffocated by barium given for x-ray diagnosis, the lower respiratory tract at necropsy being filled by the barium meal.

The necropsy findings in suffocation are identical with those in smothering. They are usually convincing since the general picture of asphyxia is found together with the foreign material in the respiratory tract.

Suffocation, as a terminating event in many diseases from natural causes, often occurs. Some of the common intrinsic causes being suffocation in laryngeal diphtheria (now rarely seen), edema of the larynx in chronic nephritis, the breaking of a peritonsillar abscess, hemoptysis in pulmonary tuberculosis or ruptured aneurysm.

Extrinsic causes such as suffocation in mediastinal Hodgkin's or other malignant growths of the chest, aortic aneurysms, empyemas with pleurobronchial fistula, and similar diseases, may produce suffocation.

The necropsy will clarify the situation, and it should be recalled that edema of the larynx is never so pronounced at necropsy as it has been during life.

ASPHYXIA DUE TO INTERFERENCE WITH MOVEMENTS OF RESPIRATION

Compression of chest and abdomen

Victims accidentally caught in a collapse of buildings, in "cave in" of excavations, or crushed between machinery, between two objects, beneath overturned automobile, or crushed in a crowd, in elevator accidents, et cetera, may die from asphyxia due to fixation of the chest and abdomen, preventing respiration.

Often no external marks of injury may be present but usually the necropsy will disclose many of the characteristic signs of an asphyxial death.

Traumatic asphyxia. Occasionally in such crushing accidents the sudden mechanical pressure may overdistend the capillaries of the face and neck causing a deep purple discoloration down to the clavicles where a sharply demarcated horizontal line occurs with normal appearing skin below it. The appearance of the patient is striking and weird. The discoloration may disappear in one to two weeks without passing through the color changes of a bruise.

Homicidal crushing. Occasionally murder is committed by kneeling on the chest of a victim, often without producing any external marks of injury. In "burking" the respiratory movements are sometimes prevented by sitting on the chest of a victim while the hands or a cloth are used over the face for the purpose of smothering.

In the middle ages, men were sometimes tortured and put to death by the placing of heavy boards and stones on the chest and abdomen, producing death by the interference of normal muscular movements of respiration.

Paralysis of respiratory muscles

Paralysis of the diaphragm and intercostal muscles occurring in such diseases as poliomyelitis, acute ascending paralysis, et cetera, may produce death by asphyxia. Fortunately the use of respirator cabinets may tide a few cases over until the disease subsides.

ASPHYXIA DUE TO PRESENCE OF IRRESPIRABLE GASES

Death by inhalation of irrespirable gases is usually an asphyxiation, and one may, with quite correctness sign, for instance, a death certificate "asphyxiation by illuminant gas, accidental, gas range, coffee pot boiled over."

Much, however, depends upon the nature of the gas inhaled as to whether death is due to a true asphyxiation, some specific poisonous action of the gas itself, or to a combination of both.

Henderson and Haggard[6] have called attention to two types of asphyxia which may be applied to the inhalation of noxious gases.

In the first, which is caused by gases not usually considered as asphyxiants, for example hydrocyanic acid gas, respiration is quickly stopped by their poisonous effects on the respiratory centers. The tissues are deprived of oxygen and the elimination of carbon dioxide ceases. Due to the developing anoxemia and excess of CO_2 in the tissues, the effects are fatal.

In the second type, which is caused by the real asphyxiant gases, such as carbon monoxide, there is no cessation of breathing, except as a terminal event. The tissues are primarily deprived of oxygen but carbon dioxide continues to be eliminated and if excessive breathing takes place may be greatly depleted, adding to the anoxemia the condition of acapnia.

The number of gases which have caused death by inhalation either accidentally, or with suicidal or homicidal intent is large. In addition, poisonous gases play an important part in modern warfare and are beginning to be used in judicial executions.

A few of the common gases may be mentioned: Carbon monoxide, carbon dioxide (choke damp), hydrogen sulphide (stink damp), arseniuretted hydrogen (arsine), methane (marsh gas), bromine, chlorine, ammonia, the mineral acids, methyl chloride (in refrigerating systems), hydrocyanic acid gas, the anaesthetics, chloroform, ether, nitrous oxide, ethyl bromide and chloride and the war gases.

The reader should consult the classical writings of Henderson and Haggard,[6] and the works of Webster[9] and Smith[8] for the

action and toxicology of these gases and the works of Herzog for the medicolegal aspects.

The enormous number of asphyxial deaths due to illuminating gas, auto exhaust and coal gas, necessitates a discussion of by far the most important of all the irrespirable gases—carbon monoxide.

CARBON MONOXIDE POISONING

Suicidal asphyxiations

The inhalation of illuminating gas is the common method of committing suicide in most civilized countries, because of its accessibility, cheapness, and supposed freedom from pain.

In New York City during a five year period (1928–1932), in a total of 7,219 suicides there were 3,003 suicides by illuminating gas or 41 percent, eight by auto exhaust and none from coal gas.

The number of suicidal asphyxiations from carbon monoxide would be much larger if one included many probable suicides, which, because of a reasonable doubt or from lack of proof, had to be classified as accidental.

Accidental asphyxiations

During this same period in New York City there were 4,677 accidental asphyxiations, 2,042 or 43 percent of these were killed by illuminating gas, seventy-nine by auto exhaust and seventy-four by coal gas.

My opinion is that most auto exhaust asphyxiations are suicides since considerable publicity in the press has warned the public concerning the danger of a running motor in small garages. In no other form of suicide can the circumstances of an accident be so mimicked by the person committing suicide as in these individual garage asphyxiations. The insurance companies usually "dig up the dirt" later when the question of payment of a double indemnity accident policy is raised.

Homicidal asphyxiations

In New York City during this same five year period there were forty-five homicides by illuminating gas, a very large number.

Most homicides in Essex County from gas have been caused by a person committing suicide who kills at the same time another person either accidentally or with homicidal intent.

The importance of carbon monoxide poisoning to a community can again be well illustrated by the New York City statistics. The same figures exist in every large city in the country.

During this same five year period in New York City there were 5,251 deaths from carbon monoxide poisoning which includes all the illuminating gas, auto exhaust and coal gas cases. This is an average of over 1,000 deaths a year. As a cause of violent death it is exceeded only by the highway accidents to which it runs a close second.

Certainly over one-half of these deaths all over the country are accidental and due to faulty and leaky gas fixtures, carelessness, intoxication, and a lack of interest by laity, hospital authorities and the medical profession in quick, competent resuscitation methods in asphyxiation.

Necropsy findings

External examination. In bodies found dead as the result of carbon monoxide whether from illuminating gas, auto exhaust or coal gas, the postmortem lividity is a characteristic bright pink color. This color is distinctive and not seen to such an extent in any other form of death. The face often appears natural, as if alive. Occasionally a similar color, although rarely so pronounced, may be seen in bodies exposed to cold and in cyanide poisoning.

If the body is found on its back, this color will be most pronounced over the back of the neck, shoulders and body. If the body is face downwards the bright red lividity will be noted over the front of the body, and will shift in a short time to dependent parts if the body is turned over, provided the blood is still confined to the capillaries and postmortem decomposition has not set in.

If the medical examiner is satisfied as to the cause of death and contemplates releasing the body for burial without a necropsy, it is often wise to obtain a specimen of blood for the toxicologist,

by aspiration from the heart. It often settles any argument as to cause of death.

When such a body is buried, it may be exhumed several months or even years afterwards, carboxy-hemoglobin may not only be detected in the blood, but even the amount of saturation estimated.

Usually a body of a person dying from carbon monoxide remains in a state of good preservation but we have, occasionally, seen very rapid postmortem decomposition.

Internal examination. In the examination of a person found dead from carbon monoxide or dying shortly after exposure, the outstanding finding is the bright cherry red color of all blood containing organs and of the blood itself. It is so pronounced that it is characteristic of carbon monoxide. The right heart is distended with this bright fluid blood. Pulmonary edema with bright pink foam in the air passages and considerable cerebral edema is often found.

If the person has been taken to a hospital and resuscitation methods, such as the administration of carbon dioxide and oxygen, restores respirations, carbon monoxide rapidly leaves the body and in a few hours an examination of the blood for carboxy-hemoglobin will be negative. The patient, however, may remain in coma and die in two or three days.

If such a body is examined after death all chemical and spectroscopic tests for carboxy-hemoglobin will be negative. The correct diagnosis in such cases often rests upon the finding of bilateral degeneration in the lenticular nuclei (Kolisko's lesions). These bilateral areas of necrosis are usually situated in the globus pallidus, are from 1 to 2 cm. in diameter, elongated in shape, brownish in color showing no hemorrhage, and grossly appear like areas of thrombotic softening. They are caused during the period of anoxemia due to the brain tissue being deprived of oxygen for too long a time. Their peculiar location is dependent upon the sharp right angles made by the nutrient arteries supplying the basal ganglia.

In two persons recently examined and who had been given intravenous injections of methylene blue in a forlorn and mis-

guided hope of saving the victims, typical areas of lenticular nucleus softening were found. On exposure to the air the nuclei turned a bright blue color, the rest of the brain remaining normal in appearance. This is a beautiful confirmation of the work of Burrows[1] on the localization of certain dyes in inflammatory areas after injection into the blood stream. The other organs which showed discoloration by the methylene blue were those chiefly involved in its elimination, the bladder and urine being a deep blue color, and the kidney pelves, ureters, and mucosa of stomach, colon and gall bladder becoming bluish on exposure to air.

Toxicological examination. Samples of blood taken at necropsy usually from the right heart, should be placed in small vials, filled to the top and tightly corked. In exhumed bodies, blood may sometimes be obtained from the cerebral sinuses when it cannot be procured easily from other locations.

These specimens should be examined by the toxicologist for the presence of carboxy-hemoglobin using chemical and by spectroscopic tests.

In medicolegal work one must no longer be satisfied with a qualitative report, since even in the blood of smokers, small amounts of carboxy-hemoglobin may be found. Quantitative estimations showing the percentage of saturation in the blood, using preferably the methods of gas analysis devised by van Slyke, is essential for a proper interpretation of the case.

In Gettler's experience, 18 to 20 percent saturation is necessary to produce symptoms, over 30 percent is dangerous and 45 to 65 percent causes paralysis and death. Contrary to other authorities he seldom finds a saturation higher than 65 percent.

ASPHYXIA DUE TO ACTION OF POISONS ON THE NERVOUS SYSTEM

Death by asphyxia is common in acute alcoholism and may occur from an overdose of morphine, hyoscine, avertin, sodium amytal, and other drugs, or from the administration of a general anaesthetic due to the direct action of these poisons or drugs on the central nervous system. It is fair to assume that numerous deaths due to drugs and anaesthetics are not reported in many communities.

In investigating anaesthetic deaths it should be constantly borne in mind that very often surgical shock and poor anaesthesia cannot be determined or properly evaluated at the postmortem table. In some instances much depends on whether the medical examiner believes there is such a condition as "status lymphaticus." Notwithstanding the opinion of Greenwood and Woods[5] and the report of the Status Lymphaticus Investigation Committee of the Medical Research Council and Pathological Society of Great Britain and Ireland[10] tending to show that it is as accurate to attribute the cause of death to "the visitation of God" as to status lymphaticus and that in the future such a condition for a cause of death will probably not be accepted by reliable authorities, I still believe persons suffering from this characteristic type of constitution die suddenly under anaesthesia and during trivial surgical or other procedures.

The correct diagnosis of most of these cases will rest upon a competent toxicologist. The methods devised by Gettler[3] for recovering alcohol from the brain and the estimation of the degree of intoxication has been of enormous practical value in our work as medical examiners.

OTHER FORMS OF ASPHYXIATION

In a discussion of asphyxial deaths I have not considered an important group which would almost double the number of asphyxial deaths in any community, namely "asphyxia neonatorum."

Under this heading the following may be classed as capable of response to resuscitation properly applied: asphyxias due to cord pressure, breach extractions, malposition, deformed pelves, difficult labor, antenatal and postnatal atelectasis, prematurity, etc. This is of prime importance to investigators of infant mortality and obstetricians.

Space does not permit a discussion of the asphyxias in electric shock, lightning, conflagrations, et cetera.

The argument may be advanced that we all die of asphyxia as in many deaths from natural causes asphyxia often terminates life. The test of true asphyxial deaths, however, readily disposes

of this contention. The treatment of asphyxia is the removal of the obstruction to respiration and the application of artificial respiration.

FIG. 47. EXAMPLE OF A COMMON METHOD OF COMMITTING SUICIDE BY HANGING

The individual usually stands on a chair, box or other object, adjusts noose and kicks the support away. Occasionally, however, consciousness is lost so rapidly that he may fail to kick over support. In this case the right foot is still resting on chair, the left hanging free. (After Hofmann—Lehrbuch der gerichtlichen Medizin.)

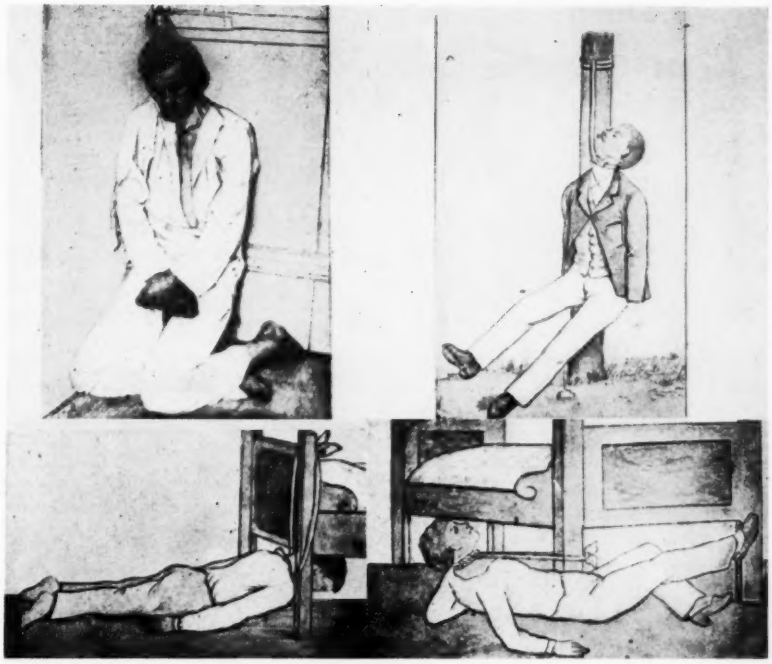

FIG. 48. EXAMPLES OF LESS FREQUENT METHODS OF COMMITTING SUICIDE BY HANGING

These cases illustrate the salient fact that complete suspension of the body is not necessary in committing suicide. Hanging in the standing, sitting or reclining position is by no means uncommon. (After Hofmann—Atlas der gerichtlichen Medizin.)

FIG. 49. TYPES OF NOOSE FREQUENTLY USED IN SUICIDAL HANGING

The picture on the left shows the use of a fixed loop. In such a case the imprint of the knot on neck or face is usually absent.

The picture on the right shows a running noose. In this case the knot which is firmly pressed into the flesh, makes a mark. (After Hofmann—Atlas der gerichtlichen Medizin.)

FIG. 50. THE FURROWS OR CONSTRICTION MARKS IN SUICIDE BY HANGING

The typical oblique furrow with its pale base and hyperemic border made by the rope, may be noted. The loop in this case was a fixed one, being so adjusted that the knot came in front of the left ear without pressing into the skin. (After Hofmann—Atlas der gerichtlichen Medizin.)

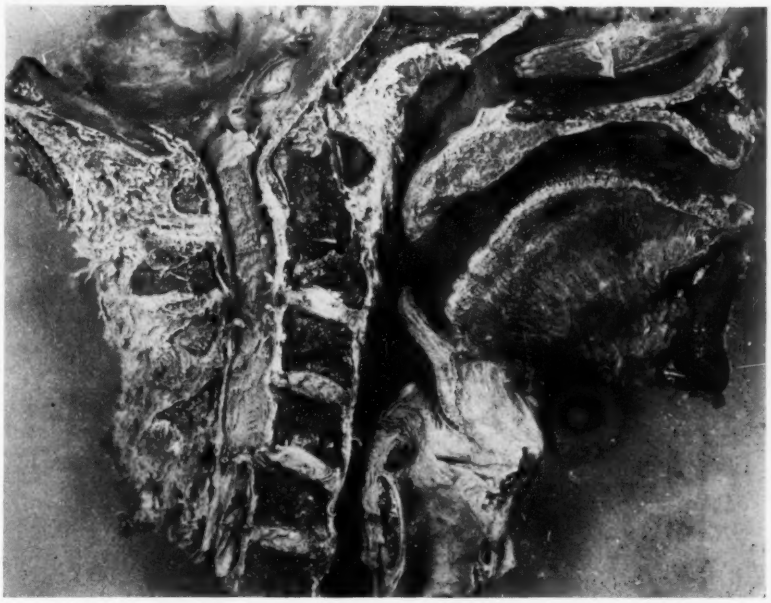

FIG. 51. MEDIAN SECTION OF NORMAL HEAD AND NECK TO ILLUSTRATE PATENCY OF AIR PASSAGES

Note the normal position of the tongue, soft palate and uvula; the normal space between base of tongue and epiglottis; the erect position of the epiglottis; the normal space between posterior surface of the epiglottis and the posterior pharyngeal wall; the distance of at least 3 cm. between the top of the epiglottis and the interarytenoid arch, allowing full view of the vocal cords from above; the space between the soft palate, uvula and the posterior pharyngeal wall allowing free access of air from nasal passages to glottis; and the wide open structures through which air has a free passage back and forth with respiration.

All these spaces with their accurate measurement is of prime importance in the establishment of death due to strangulation, and not the ordinary data usually furnished in these cases, such as the color of face, presence of fluid blood, petechia, etc. Most of the real evidence has escaped notice because the usual autopsy technique almost entirely destroys it. (Office of Chief Medical Examiner, Essex County, N. J.)

FIG. 52. MEDIAN SECTION OF HEAD AND NECK IN SUICIDE BY HANGING WITH CLOTHES LINE

Note position of tongue. Its base is pushed backward and upward by the traction of the rope, and because the point of traction is just below the hyoid bone, the tip of the tongue has been pushed anteriorly, projecting between anterior dental arcade (which in this case is formed by artificial plates).

Note that the base of tongue is jammed back into throat completely cutting off the entrance and exit of air in respiration.

The normal space between base of tongue and epiglottis is obliterated so that the base of tongue lies in apposition with the anterior surface of the epiglottis. The epiglottis is pushed backward so that its posterior surface is in apposition with the posterior pharyngeal wall, effectively blocking the glottis.

The soft palate is pushed backward and upward, its posterior or superior surface coming in apposition with the posterior pharyngeal wall, effectively blocking the passage of air from the nasal cavities. The uvula in this case is caught and bent anteriorly against the inferior surface of the soft palate. Office) of Chief Medical Examiner, Essex County, N. J.)

FIG. 53. MEDIAN SECTION OF HEAD AND NECK IN SUICIDE BY HANGING WITH LEATHER BELT

Note the position of the tongue. On account of the width of the belt there has been compression and traction on tissues above and below the hyoid bone. On account of the high compression and angle of traction, the tip of tongue remains in mouth in back of anterior dental arcade. Otherwise, note the same obliteration of the normal spaces as seen in the preceding case with effectual blocking of air from nasal cavities and from mouth. Note complete blocking of glottis by epiglottis. (Office of Chief Medical Examiner, Essex County, N. J.)

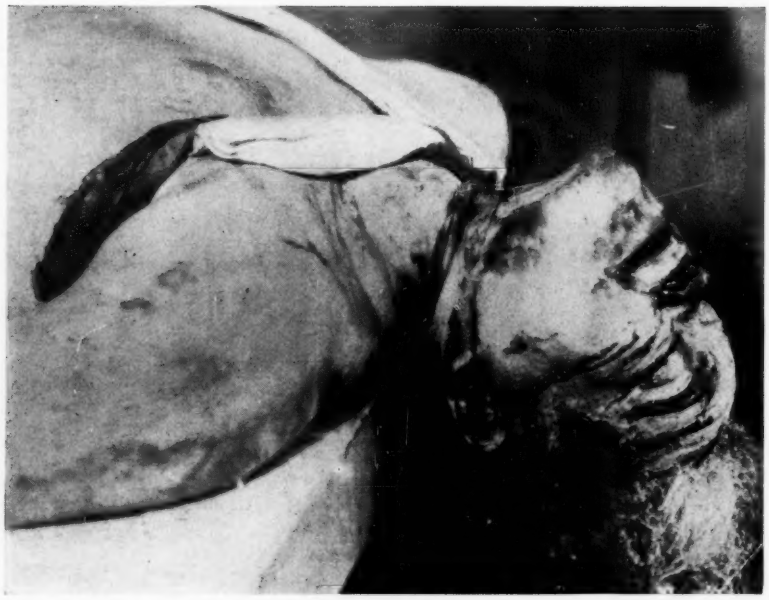

FIG. 54. HOMICIDAL STRANGULATION BY LIGATURE IN COMMITTING RAPE

In this case, a stocking tightly tied running horizontally around the neck, with the knot in front, may be noted. Numerous scratches and abrasions received in the death struggle may also be noted. At autopsy it is important to remove the ligature without destroying the knot, as the manner of tying may be a valuable clue. (Office of Chief Medical Examiner—New York City.)

FIG. 55. SACK MURDER

The deceased was strangled, trussed up in a sack and dumped into a river. The character and method of tying the knots may be of great importance in tracking and convicting the murderer. Therefore, extreme care should be taken in removing the ropes at autopsy. (Office of Chief Medical Examiner—New York City.)

FIG. 56. MANUAL STRANGULATION—NEWBORN INFANT

Typical finger-nail impressions on the neck may be noted. (Office of Chief Medical Examiner—New York City.)

FIG. 57. HOMICIDE BY MANUAL STRANGULATION

Over left side of the neck typical finger-nail marks may be seen caused by the right hand of a giant negro. The span of the murderer's hand was so great that the marks made by the right thumb can be seen over the right clavicle. The great horn of the hyoid bone was fractured on the right side. Autopsy showed, in addition to the general signs of asphyxiation, the typical position of the soft parts of the throat seen in these cases. (Office of Chief Medical Examiner, Essex County, N. J.)

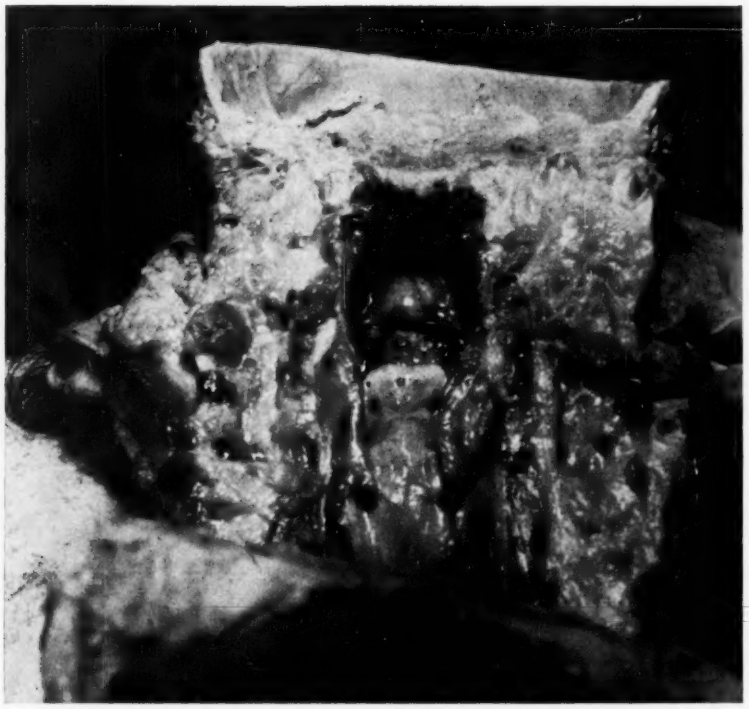

FIG. 58. POSITION OF ORGANS OF MOUTH AND NECK IN MANUAL STRANGULATION AUTOPSY FINDINGS IN CASE SHOWN IN FIGURE 57

The skull has been split horizontally by sawing through the middle of the basilar portion of occipital bone exposing the retropharynx. The obliteration of the air passages may be noted, the epiglottis being pressed back and closing the glottis, and the base of tongue forced back against epiglottis and soft palate. The vocal cords cannot be seen. Compare with normal conditions shown in Figure 59. (Office of Chief Medical Examiner, Essex County, N. J.)

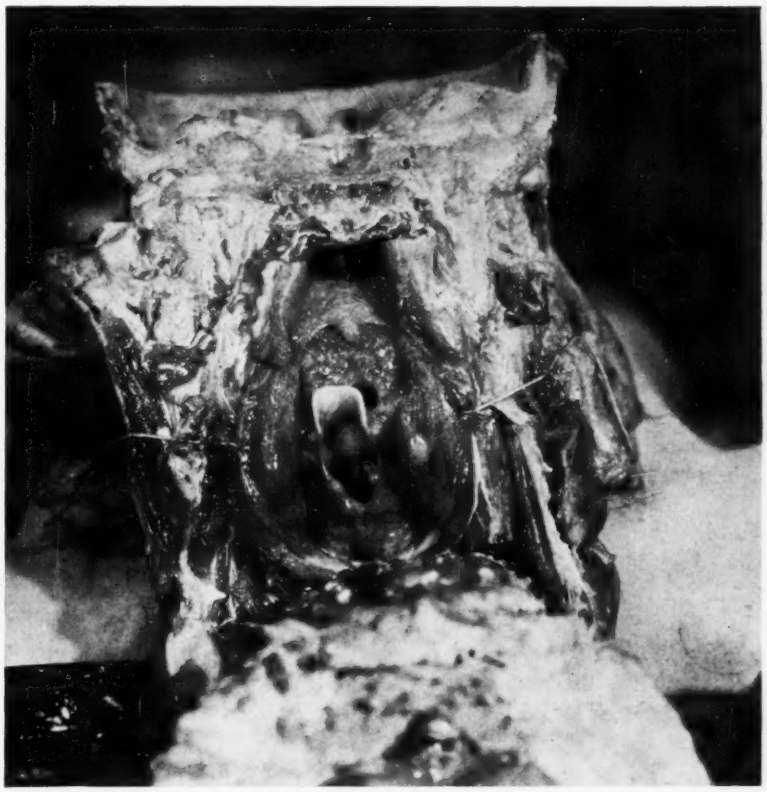

FIG. 59. NORMAL POSITION OF THE ORGANS OF MOUTH AND NECK

Note the normal erect epiglottis with patent glottis exposing the vocal cords; and the normal space between the base of the tongue and epiglottis. None of these parts are forced back against the posterior pharyngeal wall. (Office of Chief Medical Examiner, Essex County, N. J.)

In preparing this sketch I have tried mainly to give my experiences as a medical examiner, disregarding the extensive literature and the reports of unusual cases.

I have often used material in an indirect manner and quoted opinions verbatim from the following books, to the authors of which I wish to acknowledge my indebtedness: *Forensic Medicine* by Sydney Smith, one of the clearest, most concise, accurate and readable books on this subject, *Legal Medicine and Toxicology* by Ralph W. Webster and *Medical Jurisprudence* by Alfred W. Herzog.

I am under deep obligation to Dr. Charles Norris, Chief Medical Examiner of New York City, for permission to use statistics or material from his office that was deemed necessary; to his deputy, Dr. Thomas A. Gonzales, for his observations on manual strangulation; and to Dr. Milton Helpern, assistant medical examiner, for the excellent photographs of many of their cases.

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APPENDIX

REPORT ON NECROPSIES*

PREPARED BY THE JOINT COMMITTEE REPRESENTING THE NEW YORK ACADEMY OF MEDICINE, THE NEW YORK PATHOLOGICAL SOCIETY AND THE METROPOLITAN FUNERAL DIRECTORS' ASSOCIATION

The joint committee began its work in 1930 and rendered a report on April 8, 1931, which was approved by the Council of the New York Academy of Medicine on May 27, 1931, and published in the *Bulletin of the New York Academy of Medicine* (**7**: 533,1931). In accordance with the recommendation in section D, paragraph 3, of that report a continuing joint committee was designated to carry on the work of cooperation. Because of the unexpected large demand for copies of this original report the available reprints have become exhausted. The continuing committee therefore submits the present revision as a second report on necropsies, and recommends its adoption and printing in a periodical of wide circulation.

A. DESIRABILITY OF NECROPSY

1. All agree that postmortem examination by a pathologist is desirable; first, to provide reliable recorded information concerning the cause of death and the nature of the various disease processes; second, to confirm or amend the opinions formed by the physicians during the life of the patient, so that they may serve the next patient with greater confidence and skill; third, to reveal to the physicians continually the physical changes in the interior of the body which are associated with disordered behavior during life; fourth to provide for the advance of human knowledge con-

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cerning the nature of disease in general. It is well recognized that the practice of postmortem examination in a hospital exercises a constant influence to improve the service and to correct serious deficiencies, as well as to improve diagnosis and prevent disease.

B. COOPERATION OF HOSPITAL AUTHORITIES AND FUNERAL DIRECTORS

1. The hospital and its medical staff have not completed their service to the family on the death of a patient. They owe to the family a further service, namely, to give an account of what has occurred, together with the most accurate possible explanation. This requires that some representative member of the family come to the hospital for a personal interview and give permission for the examination of the body of the deceased. The funeral director must recognize this relationship and should not oppose the proper efforts of the hospital authorities and the physicians in the discharge of this obligation.

2. The funeral director is particularly interested in getting into his own hands: (1) the death certificate, (2) the permit to remove the body and (3) the body itself, so that he may prepare it in a satisfactory manner for the funeral ceremony. He must feel certain that nothing will arise to interfere with his plan and program. Unforeseen delay may require cancellation of contracts for transportation and various other services, thus increasing the expense and causing dissatisfaction. Unreasonable delay by the hospital, in its attempt to obtain permission for necropsy, is therefore objectionable to the funeral director. The conflict of interests in this connection requires mutual consideration and a spirit of cooperation on the part of all concerned. Disputes of this nature should therefore be adjudicated by a permanent joint committee on cooperation.

3. The funeral director or his agent must present to the hospital acceptable evidence that he has been authorized by the family to take charge of the body. The blank form employed for this purpose should conform with the requirements of the department of health.

4. Hospital employees, in general, must not give information to favored funeral directors or to any other unauthorized persons in regard to persons critically ill or dead in the hospital. It is proper for the chief administrative officer of the hospital, when requested by the family, to refer the selection of a funeral director to the office of the local Funeral Directors' Association, or, quite properly, to select one by rotation from an approved list in his own office. Such a selection must never be left to a minor employee of the hospital. Proof that a minor employee has offered recommendations of this sort should be followed by his instant dismissal from the service.

5. The hospital authorities should make certain that the necessary data for a death certificate, except those facts relating to the nature, progress and termination of the present illness, are entered on the record at the time of admission of the patient. Data such as the date of birth and the maiden name of the mother may be obtainable only with great difficulty after death of the patient. The death certificate may be filled out by a clerk using a typewriter, leaving only the diagnosis and signature to be supplied by the physician who completes the certificate.

6. Report of a death to the medical examiner should be made in those circumstances where this is legally required, and the decision to notify this official should be made at the time of death of the patient, entirely without regard to the attitude of the relatives concerning necropsy. It is improper for any member of the hospital staff to threaten to call the medical examiner if permission for necropsy is refused. Threatening or browbeating of this nature may be regarded as evidence of lack of ability to handle the situation.

7. In general, the permission for necropsy should be asked for as soon as possible after death. Often it is best to make the request at once whenever the proper relative of the deceased is present in the hospital. Reasonable consideration should be accorded to every one concerned in determining when the matter has been adequately presented and the final decision reached.

8. Arrangements should be worked out in every hospital whereby the unnecessary loss of time on the part of the funeral

director may be obviated, and the funeral director should be instructed that he will be promptly informed by telephone when the death certificate is signed and the body is ready for him.

The telephoned information in regard to the dead, particularly before a funeral director is known to have been engaged, should be given only by an executive officer of the hospital and should be carefully guarded unless the persons on the wire are personally known.

9. Interference by a funeral director with the legitimate efforts of the hospital to obtain permission for autopsy shall be regarded as a reportable grievance.

C. TECHNIC OF THE NECROPSY

1. In males, the incision is to extend from the suprasternal notch to the pubes in the midline, passing to the left of the umbilicus. In no circumstances shall the incision in males be extended further upward.

2. In females and in sailors who are to be buried in uniform, the V-shaped incision is to be used, that is, an incision extending from the acromial end of the clavicle to the xiphoid and up to the acromial end of the corresponding clavicle. The flap thus outlined must be dissected upward close to the deeper structures, and every effort must be made to prevent perforation of the skin in the process of dissection.

3. At least from one-half to 1 inch (1.2 to 2.5 cm.) of the external carotid arteries is to be left free and ligated. The internal carotids and the vertebrals are to be ligated, and at least from one-half to 1 inch of the iliacs is to be left intact and ligated.

4. The scalp is to be divided by an incision behind the ear, extending from one mastoid process to the other, as indicated in figures 2 and 3. The incision is to pass over the vertex when the hair is abundant, or somewhat posterior to this line when it is sparse. In women, the hair is to be parted along the projected line of incision to avoid cutting it. For the same reason, after the initial incision has been made, the knife should be carried in such manner that its sharp edge faces the dissector. Care should be taken not to tear or otherwise injure the scalp. The scalp is

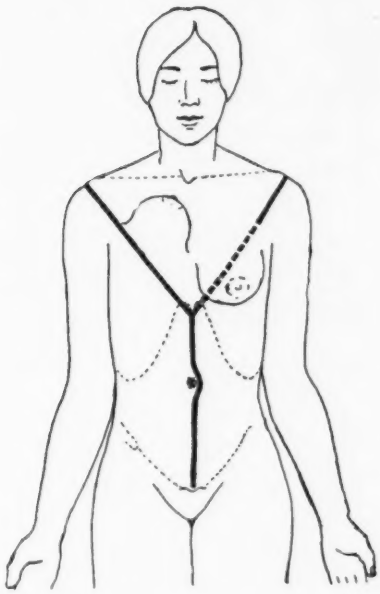

FIG. 1. DIAGRAM ILLUSTRATING INCISIONS IN TRUNK

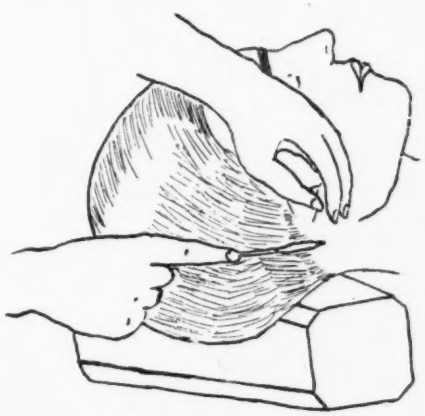

FIG. 2. INCISION IN SCALP

reflected backward and forward, so that the calvarium is exposed anteriorly slightly above the frontal eminences and posteriorly somewhat behind the occipital protuberance.

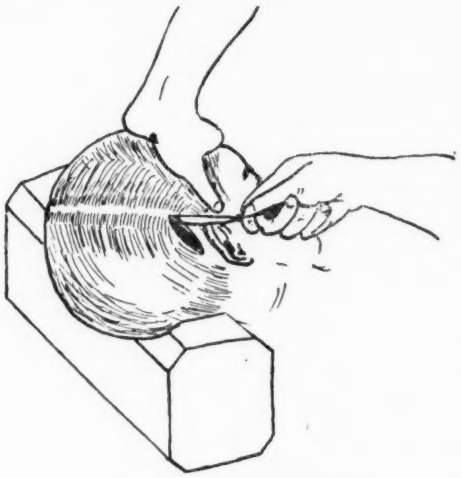

FIG. 3. INCISION IN SCALP

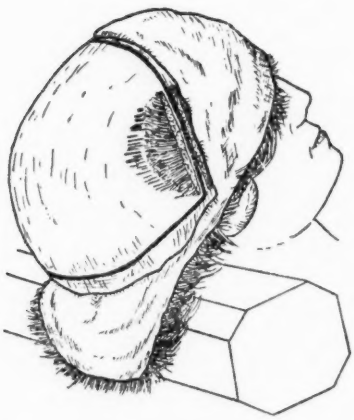

FIG. 4. REMOVAL OF SKULL CAP

Before the skull is sawed, the line through which the saw is to be carried is to be mapped out with the aid of a sharp instrument (fig. 4). The temporal muscles are to be cut on a plane parallel

with the projected line (fig. 4) to preserve stumps on either side long enough to provide for suturing and immobilization of the replaced calvarium.

5. The removal of the skull cap is to be planned and carried out in such a manner as to insure its secure approximation. This is best accomplished by sawing in two intersecting lines which meet at an obtuse angle behind the ear (fig. 3), the anterior incision commencing at the level of the hair line.

6. Before closing the cranial cavity, every effort should be made to provide against leakage. This is best carried out by the following procedures: (*a*) by ligating the carotid and vertebral arteries, (*b*) by plugging the foramen magnum tightly with cotton and (*c*) by filling the cranial cavity with oakum.

7. In suturing the skin a moderately small needle should be used so as to avoid leakage and disfigurement.

8. After the autopsy is completed, the body is to be delivered to the embalmer in a thoroughly clean condition—the skin washed, all cavities thoroughly sponged and dried and no source of leakage allowed to remain.

9. After the completion of the autopsy, the embalmer is to be allowed the use of the autopsy room for the preparation of the body for burial, provided that this does not conflict with the immediate use of the room for another autopsy and provided also that the embalmers leave no cleaning to be done by the hospital employees.

GEORGE BAEHR, M.D., *Chairman.*